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# System Analysis of Shallow Land Burial

## Appendix

Prepared by D. Lester, D. Buckley, S. Donelson, V. Dura, M. Hecht, W. Horton, T. Nakai, T. Pasternak, L. Robertson, R. Stula, J. Stoddard

**Science Applications, Inc.**

**Prepared for**
**U.S. Nuclear Regulatory Commission**

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NUREG/CR-1963
Vol. 3

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Appendix

Manuscript Completed: January 1981
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Prepared by
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**Prepared for**
**Division of Waste Management**
**Office of Nuclear Material Safety and Safeguards**
**U.S. Nuclear Regulatory Commission**
**Washington, D.C. 20555**
**NRC FIN No. B6428-9**

READEX FICHE

## ABSTRACT

This appendix is Volume 3 of a three volume report on the Systems Analysis of Shallow Land Burial Project and contains the complete data base.

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# APPENDIX A

# SITE VISITS

## APPENDIX A-1, SITE VISIT TO MAXEY FLATS

The Maxey Flats low-level radioactive waste disposal site is located near the town of Morehead in Fleming County, northeastern Kentucky. The area of the site is about 200 acres. The area adjacent to the site is a sparsely populated agricultural district whose primary activities are cattle grazing, growing of corn and tobacco, and operation of lumber mills. The topography of the region consists of rolling hills and valleys. Maxey Flats is situated on top of a broad mesa with moderately steep valleys bordering the area on the eastern and southern margins. The area is drained by Rock Lick Creek.

The site operated in a commercial mode from 1963 until 1977. In December of 1977 the site was ordered shut down for two years during which a study of safety factors pertaining to water infiltration into trenches was made. The two-year period was recently completed, but the prospects for reopening the site to commercial operation are very slim. The site is essentially in the controlled storage phase. The problems with water infiltration are still being studied as are the different potential pathways of radionuclide release. A number of experiments are being performed by various organizations to determine the migration of radionuclides at the site.

The major problem has been the collection of water in the trenches. The bottom layer of the trenches is essentially impervious to water. Water collects in the trenches and must be removed via a sump pump to holding tanks or ponds. The ponds mentioned above are lined with tarps both below and above the liquid, isolating the water from the air environment. The liquid is then processed via evaporation. In the past, contact dose rates at the tank surfaces have been as high as 20 mR/hr.

Operation at Maxey Flats apparently improved as the site was used more. In the early 1970's, attempts were made to "clean up" the operating procedures. Rumors of waste shipments being searched for "useful" items in a manner similar to the problems at Beatty do exist. However, no data is available to substantiate the rumors. At the time of closure in 1977, these practices were definitely not a part of the operation.

Trench construction was similar to construction at other sites. The markers indicating early trenches appear to be poorly placed. The contrast to the newer Barnwell site is quite apparent. Early trenches often had poor isolation of materials. For example, one trench contained all strategic nuclear material while another contained only liquid waste solidified with concrete. One trench had a waste shipment containing 600,000 curies of tritium buried in it. This is noted since tritium migration is a major concern.

High exposure rate ("high-intensity") waste loads were received at the site and buried. The highest exposure rate at contact was about 10,000 R/hr. The loads were generally activated metal components from research and power reactors. Operational problems did occasionally occur with these loads. The practice was to remove the loads from the transporter casks using cranes or similar pieces of equipment. On at least one occasion, equipment such as hoist attachments failed and left exposed loads above the ground. The apparent solution was to move away from the load, regroup, and determine the best method to solve the problem. It appears the potential for exceeding exposure limits in such instances was very high.

The evaporation process, which runs continually, takes water pumped from the trenches and stored in tanks or ponds and evaporates it using a propane/air-injected mixture ignited in a container of the water. The exhaust exits through a stack on the evaporation equipment building. About 6,000 curies of tritium are discharged per year. The maximally exposed individual (located at the nearest residence within one-quarter of a mile) receives about 2.2 mrem annual total body dose via inhalation.

At the time of closure, plans were being made to use movable covers over the trenches being filled. This was to prevent the collection of rainwater in the trenches during the filling operations. However, these were never used. A small crude example of one cover is presently on-site near a small trench being used for waste presently generated on-site.

Studies and experiments have shown, even when trenches are capped, that water will infiltrate the trenches. Therefore, it is planned to cover existing trenches with "tarp-like" material to prevent such water infiltration. The first covering should take place in 1980.

In about five years, Maxey Flats will probably be placed in a retired status. Fences will be used to keep people off the site. No permanent guard is planned at this time.

## APPENDIX A-2, SITE VISIT TO BARNWELL

The Barnwell commercial nuclear disposal site is located ten kilometers west of Barnwell, South Carolina. The site has been operated by Chem-Nuclear Systems, Inc. (CNSI) since 1971. The facility is on a 278-acre parcel of land.

All waste received at Barnwell must meet the Barnwell Site Disposal Criteria. For this reason, all customers shipping waste to the site are required to be familiar with CNSI's licenses from the State of South Caroline and the NRC. South Carolina is an Agreement State and, therefore, regulates burial operations, site design, monitoring programs, and perpetual care considerations. CNSI is licensed by the NRC to possess quantities of special nuclear material greater than can be authorized by the State of South Carolina under the Agreement State Program.

No liquid radioactive waste may be received at the site. Liquid waste may be accepted provided it is fixed as a solidified form as specified in the South Carolina license. Biological materials are accepted when packaged according to the license. No liquid organic chemical wastes in any form are accepted at the site. At the end of this appendix is an example of a shipping form with instructions required from all shippers of waste for each shipment.

Weather permitting, Barnwell is operated from 8 AM to 5 PM Monday through Friday and from 7 AM to 12 Noon on Saturday. Normal operating procedure is as follows. Drivers of trucks with waste must check in at the compound main gate. All shipments are then surveyed for contamination and radiation levels prior to acceptance. Accompanying papers are checked for accuracy and completeness. All shipments must comply within the contamination control limits found in 173.397, Title 49 of the Code of Federal Regulations.

After acceptance at the site, the waste loads are handled according to the type of waste. High curie content or high specific activity material shipments are obviously handled more carefully than large volume/low activity shipments. High curie content shipments are defined to contain a minimum of 2,500 curies.

Two types of trenches exist at the Barnwell site, the "regular" trench and the "slit" trench. The slit trenches are for handling high specific activity shipments with high exposure rates. The regular trenches handle all other waste.

At the time of the site visit (November, 1979), three trenches were in use, two regular and one slit. Another regular trench had been constructed and was being used to decontaminate vehicles. Construction of an additional trench was underway with most of the excavation having taken place.

The regular trenches have a nominal depth of 6.7 meters. The width varies from 15 to 30 meters and the length varies from 150 to 300 meters. There is a nominal one percent slope to one side where a trench drain system is installed with a nominal slope of 0.3 degrees end-to-end. Sampling points are installed every 30 meters along the drain with a sump every 150 meters. Future plans are to have sample points every 150 meters. The bottom meter of the trench is filled with pervious sand to allow any liquid present to filter through.

The slit trenches are approximately six meters deep and one meter wide. The length ranges from 75 meters to 150 meters. The slit trench presently in use can handle cask loads requiring shielding and TV-monitored operations. Concrete shield walls are in place at one end of the trench. During operation, a cask is lowered into the trench prior to remote removal of the inner container of waste. A crane is used to transport the container to the other end of the trench where it is immediately covered. Shipments are currently restricted to 15,000 R/hr at the surface.

Another method used, but not observed during the site visit, is the use of "Toner tubes." These are tube structures placed in the waste material during filling which are utilized at a later date for high exposure rate drums.

One regular trench was being used exclusively for the dumping of calcium fluoride sludge from Westinghouse. The waste was dumped directly into the trench from dump trucks. The other regular trench contained an assortment of waste including containers taken from casks. The containers had such waste as resin/demineralizer solidified waste from LWRs. The trench also contained waste barrels and crates, some of which contained depleted uranium. The barrels are rolled into the trench while all other waste is lowered by crane. The site license allows sixty feet of waste to remain uncovered at any time.

The construction of the trenches is such that the entry of surface water is retarded. The initial sand layer (approximately a meter) at the site is removed and replaced with clay that is compacted. After the trench is filled

with waste, it is covered with a minimum of 0.6 meters of compacted clay followed by 1.5 to three meters of additional cover. When completed the area is contoured and seeded to enhance rainwater runoff.

Delivery vehicles are inspected before leaving the site. The site criteria are as follows:

Sole use vehicles

(1) Fixed contamination not to exceed 0.5 mR/hr at any accessible surface

(2) Removable contamination not to exceed:
   (a) 2200 d/m/100 $cm^2$ for beta-gamma
   (b) 220 d/m/100 $cm^2$ for alpha

Unconditionally released vehicles

(1) Fixed contamination not to exceed 0.1 mR/hr at any accessible surface

(2) Removable contamination not to exceed:
   (a) 220 d/m/100 $cm^2$ for beta-gamma
   (b) 22 d/m/100 $cm^2$ for alpha

Vehicles leaving the site must be decontaminated to these levels before release. Decontamination may include wiping,, vacuuming,, sandblasting, and removal/disposal of components. At present a regular trench is used for sandblasting operations. These operations apparently take place only on calm days. A new sandblasting facility is currently under construction.

CNSI maintains a well-staffed Health Physics Group. The staff performs all site surveys, handles decontamination activities, monitors off-loading activities, and handles the environmental monitoring program. This program consists of soil and vegetation samples, environmental TLD's, air samples, and well water samples. The well monitoring program is extensive with sample points in the trenches scattered throughout the site, around the perimeter of the site, and off-site. Cores removed from initial wells extending to the watertable are examined. Saturated sand layers (lenses) identified in the core result in monitor wells being installed at the location of the saturated layers. These

wells are used to detect migration or water movement from trenches along the layers.

The volume of waste to be buried at Barnwell has recently been reduced by a license amendment issued on October 31, 1979, by the Governor of South Carolina. The press release giving reasons for phase-down and implementation follow this text. Also following is a copy of South Carolina Radioactive Material License No. 097 as amended by Amendment No. 26.

BARNWELL

PRESS RELEASE OCTOBER 31, 1979

I am announcing today the implementation of phased reduction in the volume of low-level waste being received by Chem-Nuclear in Barnwell. This phase-down will begin immediately and continue for approximately two years, at which time we will receive about one-half of the amount currently being buried there. The reduction is being accomplished by an amendment to Chem-Nuclear's operating license, issued by the State of South Carolina.

I have stated on many occasions the need for a national policy which puts the responsiblilty for low-level waste management on each state. This announcement is another element in my effort to affect a reasoned national policy in low-level nuclear wastes. The absence of such a policy has now put all of the burden on South Carolina. Figures now show that over one-half of the waste now being buried at Chem-Nuclear comes from seven states in the Northeast and Midwest. It is imperative that these and other states take action now to develop other sites across the country. There are no legitimate impediments to such action. The NRC has said publicly it will lend its full resources to any state wishing to locate a low-level site within its borders. It is now up to the Governors of each state to exhibit a responsive attitude, and begin to take responsible action.

I also want to clarify one misconception that has surfaced in recent reports. This action in no way affects waste generated in South Carolina that is presently eligible to be buried at Barnwell. The license amendment states that Chem-Nuclear must guarantee burial capacity for all South Carolina waste. Therefore, any waste which is generated in South Carolina and meets the criteria set by the state for burial at Chem-Nuclear, and which is properly packaged, labeled, and transported according to all state and federal rules and regulations will be accepted at the site under this amendment.

Furthermore, this action will not affect the crisis developing in nuclear medicine. For some time now, the state has been unable to allow burial of liquid organic chemical wastes at the site in Barnwell. Most of the material of this type has been transported for disposal in Washington state. There will be no change in this standard under the license amendment being issued today.

Finally, in accordance with my request, the Department of Health and Environmental Control now has full-time personnel on the site at Chem-Nuclear. These individuals will be inspecting all shipments as they arrive, to insure that all packaging and transporting guidelines are being met. We will not tolerate slipshod packaging and transportation procedures from any generator.

FROM Company Name _____

Contact _____

Address _____

_____

_____

Telephone # _____

TO _____

_____

## BARNWELL WASTE MANAGEMENT FACILITY

**Operated by: CHEM-NUCLEAR SYSTEMS, INC.**

P O Box 726, Barnwell, South Carolina 29812
(803) 259 1781

RADIOACTIVE SHIPMENT RECORD FORM

Page _____ of _____

Carrier Name _____

Driver Signature _____

Date & Time Rec'd _____

Shipping Date _____

Customer Survey No. _____

(16)

Type of Cask _____

Trailer # _____

**CNSI USE ONLY**

Arrival Date _____ Survey No _____

Date Buried _____ By _____

Radiation Reading _____ Weight _____

Trench No _____ WCC _____

LOC Code _____ Items _____

Total PERS EXP. _____

| | (1) Item Number | (2) Radio-nuclide | (3) Physical Form | (4) Chemical Form | (5) Waste Description | (6) Shipping (Grams) | (7) Source (Pounds) | (8) Activity (Millicuries) | (9) Gross Weight | (10) Trans-port Group | (11) Container Cu. Ft.* | (12) Container Spec. | (13) Rad. Level (mR/HR) Surface 1 3 R. | (14) External Removable Contamination DPM/100cm² α / β/γ | (15) Label Used |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| TOTAL | | | | | | | | | | | | | | | |

**IMPORTANT:** This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

Signature _____

Company _____ Date _____

(See Reverse Side for Instructions for Completing This Form)

Copies: White Accompany Shipment, Canary Customer, Pink Carrier

"Certification is hereby made to the South Carolina Department of Health and Environmental Control that this shipment of low level radioactive waste has been inspected in accordance with the requirements of South Carolina Radioactive Material License No. 097 as amended, and the Nuclear Regulatory Commission's License No. 46-13538-01 as amended, and the effective Barnwell Site Disposal Criteria with 48 hours prior to shipment, and further certification is made that the inspection revealed no items of non compliance with all applicable laws, rules and regulations."

Date _____ By _____

Title and Organization _____

Telephone No (___) _____

Form No. CNS-201
(9/79)

## CHEM-NUCLEAR SYSTEMS, INC.

### INSTRUCTIONS FOR COMPLETING RADIOACTIVE SHIPMENT RECORD FORM

NOTE: SHIPMENT MAY BE REFUSED IF CONTENTS, SUPPORTING DOCUMENTATION AND PACKING REQUIREMENTS ARE NOT IN COMPLIANCE WITH CHEM-NUCLEAR SYSTEMS, INC.'S STATE AND FEDERAL LICENSES, THE BARNWELL SITE CRITERIA AND APPLICABLE DOT AND NRC SHIPPING REGULATIONS.

**GENERAL**

Customer or shipper must provide (printed or typed) information in all numbered column headings.

Indicate company name, contact address and phone number, company name of carrier who is transporting the material and the date of the shipment in spaces provided.

An authorized representative of the company must sign and date the State of South Carolina and DOT Certification statements.

Column heading entries are to be made as follows:

(1) Item or container number - list each container separately. Identification on package itself shall match number in this column.

(2) Radionuclide - list each radioisotope contained in each container (See Note #3). The terms MFP and MCP **are not permitted.** Use as many lines as are required.

(3) Physical State - indicate state - solid, gas, biological.

(4) Chemical Form - reference section 172.203 of 49 CFR.

examples:

| | **waste** | **chemical form** |
|---|---|---|
| 1. | solidified liquid | urea formaldehyde (UF) (solidification media) |
| 2. | resin | metallic oxide deposited on resin |
| 3. | laboratory trash | Na or KI, SrCL$_2$, etc. |

(5) Waste description examples: (evaporator bottoms), (filter materials), (solidified resins), (irradiated metals), (animal carcasses), et cetera.

(6) SNM (Special Nuclear Material) grams - weight in grams of material as defined in 10 CFR Part 20.3 (S.C. Title A 1.2.24) cannot exceed 50 grams per 4.0 cubic feet or larger container

(7) Source Pounds - weight in pounds of material as defined in 10 CFR Part 20.3 (S.C. Title A 1.2.24).

(8) Record the activity (millicurie) quantity of **each** isotope in **each** container (including the activity of the SNM and Source Pounds).

(9) Gross Weight - weight in pounds of the disposable container (including contents). All packages in excess of 110 pounds must have weight indicated (see 49 CFR 172.310).

(10) See Section 173.390 of 49 CFR.

(11) Record external volume of container (7.5 ft$^3$ for a 55 gallon drum, 4.0 ft$^3$ for a 30 gallon drum, and 0.85 ft$^3$ for a 5 gallon pail).

(12) Indicate DOT/NRC container specification if applicable, such as Spec 7A, Type B package, strong tight container, et cetera.

(13) Record the highest measured radiation levels for each disposable container at the specified distances. Transportation Index Number (T.I.) equals mR/hr reading at 3 feet.

(14) Removable contamination levels on containers shall not exceed levels set forth in Section 173.397 (a) of 49 CFR.

(15) Packages shall be labeled as required by Sections 172.101, 172.300, 172.400, 172.403 and 173.397 of 49 CFR.

(16) Record cask identification number from name plate on cask.

(17) Record the trailer identification number in space provided.

Note: 1) The total line at the bottom of each page must be completed for columns 1, 6, 7, 8 and 11 by the customer.

2) Each resin shipment must be accompanied by an isotopic analysis representing this shipment which includes each isotope, the abundance of each and the total curie content.

3) If more than one container in the shipment contains the same percent abundance of each radionuclide: then a listing of radionuclides and their percentage abundance is required only for first container of this series. Subsequent containers in a series must be so designated. This listing or designation should be in Column #2. In addition, only the total millicurie content for each container in the series need be listed in Column #8.

4) Additional shipping papers may be required - refer to 49 CFR 172.201 through 172.203.

5) Biological shipments must comply with 49 CFR 173.386 through 173.388 in addition to the Site Criteria.

DAVE LESTER

# BARNWELL

PRESS RELEASE . OCTOBER 31, 1979

I am announcing today the implementation of a phased reduction in the volume of low-level waste being received by Chem-Nuclear in Barnwell. This phase-down will begin immediately and continue for approximately two years, at which time we will receive about one-half of the amount currently being buried there. The reduction is being accomplished by an amendment to Chem-Nuclear's operating license, issued by the State of South Carolina.

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Furthermore, this action will not affect the crisis developing in nuclear medicine. For some time now, the state has been unable to allow burial of liquid organic chemical wastes at the site in Barnwell. Most of the material of this type has been transported for disposal in Washington state. There will be no change in this standard under the license amendment being issued today.

Finally, in accordance with my request, the Department of Health and Environmental Control now has full-time personnel on the site at Chem-Nuclear. These individuals will be inspecting all shipments as they arrive, to insure that all packaging and transporting guidelines are being met. We will not tolerate slipshod packaging and transportation procedures from <u>any</u> generator

## VOLUME LIMITATION SCHEDULE

The licensee shall not receive waste in any month in excess of the volume limits specified in the schedule below. The licensee shall insure that waste generated in South Carolina which is acceptable for burial under all other terms and conditions of this license and the effective Barnwell Site Disposal Criteria is received, and that this waste is within the volume limit specified for that month.

| Month and Year | Volume Limit in Cubic Feet |
|---|---|
| November, 1979 | 189,000 |
| December, 1979 | 189,000 |
| January, 1980 | 178,000 |
| February, 1980 | 178,000 |
| March, 1980 | 178,000 |
| April, 1980 | 167,000 |
| May, 1980 | 167,000 |
| June, 1980 | 167,000 |
| July, 1980 | 156,000 |
| August, 1980 | 156,000 |
| September, 1980 | 156,000 |
| October, 1980 | 144,500 |
| November, 1980 | 144,500 |
| December, 1980 | 144,500 |
| January, 1981 | 133,500 |
| February, 1981 | 133,500 |
| March, 1981 | 133,500 |
| April, 1981 | 122,500 |
| May, 1981 | 122,500 |
| June, 1981 | 122,500 |
| July, 1981 | 111,000 |
| August, 1981 | 111,000 |
| September, 1981 | 111,000 |
| October, 1981 | 100,000 |
| November, 1981 | 100,000 |
| December, 1981 | 100,000 |
| January, 1982, and each month thereafter or until this condition is otherwise amended | 100,000 |
| Previous volume limitation | 2,400,000 cubic feet |
| Volume limitation as of October 1, 1981 | 1,200,000 cubic feet |

South Carolina Department of Health and Environmental Control

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2600 Bull Street
Columbia, S.C. 29201

October 30, 1979

Mr. Bruce W. Johnson, President
Chem-Nuclear Systems, Inc.
P. O. Box 1866
Bellevue, Washington 98009

Dear Mr. Johnson:

Your South Carolina Radioactive Material License No. 097 has been amended in its entirety by Amendment No. 26. The enclosed license supersedes the original license and all previous amendments.

Amendment of your license was necessary to further define the requirement that there shall be no detectable free standing liquids contained in radioactive waste received and buried at the Barnwell Facility. Other changes reflect clarification of existing license conditions and additional requirements as previously discussed with the Barnwell Site management.

With respect to license conditions 25. and 32., the terminology "no detectable free standing liquids" will be defined as less than 1% liquid by volume until December 31, 1980. Effective January 1, 1981, waste packages shall contain only trace quantities (not more than 0.5% or 1 gallon per container; whichever is less) of free standing liquids. Any liquids present in waste packages which are allowable until December 31, 1980, shall be non-corrosive with respect to the container. Effective January 1, 1981, the allowable trace quantities of liquid shall also be non-corrosive.

It is the goal of the Department to enhance the stability of the waste forms consigned for burial. To that end, resins with a total specific activity of 1 μci/cc or greater, disposed of after June 30, 1981, must be stabilized by solidification. However, in lieu of solidification, or other methods such as packaging dewatered resins with only trace quantities of non-corrosive liquids in high integrity containers are being considered at this time.

It is anticipated that your company will immediately inform your customers of the changes in the amended license and the forthcoming requirements. Should you have any questions, please do not hesitate to contact me.

Very truly yours,

Heyward G. Shealy

Heyward G. Shealy, Chief
Bureau of Radiological Health

HGS:bo

Enclosure

cc: Mr. Herbert R. Oakley
Vice-President of Nuclear Sites

Mr. Louis E. Reynolds
Director, Regulatory Affairs

Mr. Lee B. Hebbard
Barnwell Site Manager

Mr. David G. Eberhack
Manager, Health & Safety

License No. 097

Amendment No. 26 amends License No. 097 in its entirety.

SOUTH CAROLINA DEPARTMENT

OF HEALTH AND ENVIRONMENTAL CONTROL

BUREAU OF RADIOLOGICAL HEALTH

COLUMBIA, SOUTH CAROLINA

## RADIOACTIVE MATERIAL LICENSE

Pursuant to the Atomic Energy and Radiation Control Act, Sections 1-400.11 through 1-400.16 of the 1962 Code of Laws of South Carolina and Supplement thereto; and the South Carolina Department of Health and Environmental Control Rules and Regulations Pertaining to Radiation Control, Part III and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This licensee is subject to all applicable rules and regulations of the South Carolina Department of Health and Environmental Control now or hereafter in effect and to any conditions specified below.

| | | |
|---|---|---|
| 1. | Licensee: | Chem-Nuclear Systems, Inc. |
| 2. | Address: | P. O. Box 726<br>Barnwell, South Carolina 29812 |
| 3. | License No. | 097<br>(Amendment No. 26 amends Radioactive Material License No. 097 in its entirety.) |
| 4. | Expiration Date: | December 31, 1981 |

Conditions - General

5. Radioactive material, except special nuclear material, may be received, transferred, stored, and disposed of by burial at a site located approximately five miles northwest of Barnwell, South Carolina, at a site located in the Seven Pines School District, Red Oak Township, Barnwell County, South Carolina, within the boundary of the land area described in Lease Agreement dated April 6, 1976. Unless otherwise authorized in this license, only radioactive material consigned for burial shall be received at the site described above.

6. The licensee shall comply with the provisions of Title A, State of South Carolina Rules and Regulations for Radiation Control, Part I - General Provisions, Part III - Standards for Protection Against Radiation, and Part VI - Notices, Instructions, and Reports to Workers; Inspections.

7. Operations shall be conducted in accordance with Chem-Nuclear Systems, Inc., Radiation Protection and Procedures Manual dated April 4, 1977, and subsequent revisions and additions approved by the Department.

8. Operations shall be conducted under the supervision of H. R. Oakley, Robert Posik, John Ott, L. B. Hebbard, Jr., David G. Ebenhack (RPO), Leonard Toner, or other individuals designated by the licensee's Radiation Protection Officer upon completion of the licensee's training program.

9. The transportation of radioactive material within the state shall be in accordance with Title A - State of South Carolina Rules and Regulations for Radiation Control, RHA 2.22, "Transportation of Radioactive Materials."

10. Radioactive materials authorized by this license are to be received at the site in shipping containers which have been approved by the U. S. Department of Transportation, U. S. Nuclear Regulatory Commission, and subject to final approval by the Department.

11. The licensee is not authorized to open any packages at its facility, except for the following:

    (a) For purposes of repairing or repackaging containers damaged in transit.

    (b) For purposes of inspecting to insure compliance with the effective Barnwell Site Disposal Criteria.

    (c) For purposes of returning outer shipping containers.

    (d) For purposes of retrieving shipment documentation and confirming package contents.

Conditions - General

12. A monthly site receipt and burial activities report shall be submitted no later than the 10th day of the following month to the Chief, Bureau of Radiological Health, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201.

13. Should any samples taken from trench monitoring wells, cluster wells, or air samples reveal increases in the concentrations of radioactive material which were determined prior to commencement of the burial operations, the licensee shall perform further surveys to determine whether or not the increase is due to the land burial operations. The licensee shall notify the Chief, Bureau of Radiological Health, South Carolina Department of Health and Environmental Control, within 48 hours of any such increases.

14. The licensee shall submit results of all scheduled environmental sampling to the Department quarterly.

15. The licensee shall maintain all records pertinent to the receipt and burial of radioactive material at the location specified in Condition 5. of this license until authorization is given by the Department for transfer or disposal of said records.

16. Licensee is authorized to possess a 100 millicurie Cesium 137 sealed source (Eberline Model No. 64-76A), for the purpose of calibrating portable survey instruments, as outlined in Chem-Nuclear Systems, Inc., Radiation Protection Procedures No. 7: Calibration of Portable Survey Instruments, submitted March 13, 1978.

17. A. Each sealed source containing radioactive material, other than Hydrogen 3, with a half-life greater than thirty days and in any form other than gas shall be tested for leakage and/or contamination at intervals not to exceed six months. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, the sealed source shall not be put into use until tested.

B. The test shall be capable of detecting the presence of 0.005 microcuries of radioactive material on the test sample. The test sample shall be taken from the sealed source or from the surfaces of the device in which the sealed source is permanently mounted or stored on which one might expect contamination to accumulate. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.

Conditions - General

C. If the test reveals the presence of 0.005 microcuries or more of removable contamination, the licensee shall immediately withdraw the sealed source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with Department regulations. A report shall be filed within 5 days of the test with the Chief, Bureau of Radiological Health, S. C. Department of Health and Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201, describing the equipment involved, the test results, and the corrective action taken.

18. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically authorized by the U. S. Nuclear Regulatory Commission or an Agreement State to perform such service.

19. The licensee may receive and process waste shipments only during normal working hours as specified in the effective Barnwell Site Disposal Criteria.

Conditions - Waste

20. The licensee shall not receive, possess, or have in his possession at the location specified in Condition 5., at any one time unburied radioactive material in excess of:

    (a) 50,000 curies of radioactive material excluding source and special nuclear materials;

    (b) 60,000 pounds of source material.

21. The licensee shall insure that all waste received at the site described in Condition No. 5 is packaged and prepared in accordance with the conditions of this license and the effective Barnwell Site Disposal Criteria. Any changes made to the Site Criteria shall have prior approval by the Department.

22. Unless specifically authorized, all radioactive waste shall be received and buried in appropriate containers.

23. A seven-day written notification shall be submitted to the Department by the licensee of radioactive material shipments to be received in excess of 2500 curies per shipment with the exception of tritium shipments.

24. Unless otherwise authorized, the licensee shall not receive waste containing any transuranic elements. However, waste containing less than 10 nanocuries total transuranic nuclides per gram of waste is acceptable provided transuranic nuclides are evenly distributed within a homogeneous waste form. This license condition does not authorize receipt or burial of components or equipment contaminated with transuranic nuclides.

Conditions - Waste

25. Unless otherwise specified in this license, the licensee shall not receive any liquid radioactive waste regardless of the chemical or physical form. Solidified radicactive waste shall have no detectable free standing liquids.

26. The licensee shall not receive waste in any month in excess of the volume limits specified in the schedule below. The licensee shall insure that waste generated in South Carolina which is acceptable for burial under all other terms and conditions of this license and the effective Barnwell Site Disposal Criteria is received, and that this waste is within the volume limit specified for that month.

Volume Limitation Schedule

| Month and Year | Volume Limit in Cubic Feet |
|---|---|
| November, 1979 | 189,000 |
| December, 1979 | 189,000 |
| January, 1980 | 178,000 |
| February, 1980 | 178,000 |
| March, 1980 | 178,000 |
| April, 1980 | 167,000 |
| May, 1980 | 167,000 |
| June, 1980 | 167,000 |
| July, 1980 | 156,000 |
| August, 1980 | 156,000 |
| September, 1980 | 156,000 |
| October, 1980 | 144,500 |
| November, 1980 | 144,500 |
| December, 1980 | 144,500 |
| January, 1981 | 133,500 |
| February, 1981 | 133,500 |
| March, 1981 | 133,500 |
| April, 1981 | 122,500 |
| May, 1981 | 122,500 |
| June, 1981 | 122,500 |
| July, 1981 | 111,000 |
| August, 1981 | 111,000 |
| September, 1981 | 111,000 |
| October, 1981 | 100,000 |
| November, 1981 | 100,000 |
| December, 1981 | 100,000 |
| January, 1982 and each month thereafter or until this condition is otherwise amended. | 100,000 |

27. The licensee shall not receive toluene, xylene, dioxane, scintillation liquids, or other organic liquids with similar chemical properties; or containers which have at any time contained any of the liquids mentioned above. However, after complete incineration, the ash and/or residue from these wastes are acceptable.

Conditions - Waste

28. The licensee shall not receive or bury radioactive waste containing more than one (1) percent absorbed oil by volume.

29. Waste containing both toxic chemicals and radioactive materials shall require an independent evaluation of both hazards. If the chemical hazard exceeds the radiological hazard, the waste containing both radioactive material and chemically toxic waste shall not be buried at the site as described in Condition No. 5 except as specifically approved by the Department. Records of hazard evaluation of such wastes performed by the licensee shall be kept for inspection by the Department.

30. The licensee shall not store any package containing radioactive material or source material for a period greater than six months from the date of receipt of the package prior to burial.

31. The licensee may receive liquids solidified with one of the following solidification media provided the requirements of other conditions as specified in this license are met:

    (a) Dow media
    (b) Cement
    (c) Urea Formaldehyde
    (d) Asphalt
    (e) Delaware Custom Media
    (f) Solidification media and processes reviewed and approved by the U.S.N.R.C., Office of Nuclear Reactor Regulations, subject to final approval by the S. C. Department of Health and Environmental Control, Bureau of Radiological Health.

32. Ion exchange resins and filter media may be received in a dewatered form for transportation and subsequent burial and shall contain no detectable free standing liquids.

33. The licensee shall maintain records of isotopic analysis (quantitative and qualitative) for each package containing ion exchange resins received at the site.

34. The licensee shall not receive evaporator bottoms, concentrates, or other wastes containing free standing liquids unless they meet the requirements as specified in Condition 31. of this license, prior to receipt at the site.

Conditions - Waste

35. Effective November 1, 1979, the licensee shall insure that each Radioactive Shipment Record form used to describe a low-level radioactive waste shipment received at the Barnwell Site has the following certification properly executed by a representative of the shipper/generator of the waste:

"Certification is hereby made to the South Carolina Department of Health and Environmental Control that this shipment of low-level radioactive waste has been inspected in accordance with the requirements of South Carolina Radioactive Material License No. 097, as amended, U. S. Nuclear Regulatory Commission License No. 46-13536-01, as amended, and the effective Barnwell Site Disposal Criteria within 48 hours prior to shipment; and further certification is made that the inspection revealed no items of non-compliance with all applicable laws, rules and regulations.

Date:_____ By:_____

Title and Organization:_____

Telephone No. (_____) - _____"

36. The licensee shall insure that any package used as the final burial container shall be of such material and construction that there will be no significant chemical, galvanic, or other reaction among the packaging components, or between the packaging components and the package contents.

37. The licensee may bury Krypton 85 and Xenon 133 gaseous sources provided they meet the following criteria:

(a) Burial containers must be approved by the Department of Transportation.

(b) Internal pressure of containers may not exceed 1.5 atmospheres.

(c) Total activity of containers may not exceed 100 curies each.

(d) Containers must be buried in an upright position with a minimum spacing of ten (10) feet.

Conditions - Site

38. A registered surveyor must verify and document the location of each trench: (a) prior to the beginning of trench construction; (b) at the completion of trench construction, prior to the initiation of the burial operations; and (c) at the completion of the grading and seeding operation.

39. Construction of radioactive waste burial trenches, slit trenches, "Toner Tubes", trench monitoring wells and site cluster wells shall be constructed as specified in Chem-Nuclear Systems, Inc., Trench Construction Detail Drawings No. 500.101, dated December 12, 1978. Any changes to these specifications must have approval from the Department before construction begins.

Conditions - Site

40. Monitoring wells in clusters will be placed outside the trenches but in the trench area. Specific locations shall be determined through consultation. The initial well of a cluster will be core drilled to the water table and a representative sample of the core shall be submitted to the Department. The depth and number of additional wells in the cluster are to be determined by the sand-clay composition observed in the initial core. All wells shall be grouted, sealed, and capped.

41. The licensee shall not initiate burial operations in newly excavated trenches until the Department has inspected and approved the trenches. An initial inspection will be made by the Department upon completion of excavation of the trench, sumps, french drain inside the trench, drainage ditches adjacent to the trench and installation of monitoring well standpipes. An intermediate inspection will be made by the Department after the french drain and sumps have been filled with rock. A final inspection will be made by the Department upon completion of construction requirements per Trench Construction Detail Drawings No. 500.101 dated December 12, 1978.

42. Each well and "Toner Tube" must be sufficiently capped or covered to prevent the introduction of any extraneous material.

43. Open trenches and partially filled trenches shall be protected to prevent runoff water from entering trenches. Radioactive waste shall not be placed into trench areas where water has accumulated. Burial of radicactive waste into trenches with unusual amounts of water shall immediately cease until corrective action has been taken and origin of water determined.

44. The licensee shall maintain a minimum of two feet of compacted clay between the last layer of waste and the surface of the ground. Backfilling shall commence immediately as waste reaches the top elevation of the trench. Uncovered wastes shall not extend more than 100 feet beyond the backfilled portion of the trench. Upon completion of burial operations in a burial trench, the licensee shall add an additional three feet minimum of earth on top of the two foot cover. Completed trenches shall at no time be used for stockpiling earth not withstanding provisions for a final grading plan.

45. The cover over the completed burial trenches at the site specified in Condition 5. of this license shall be maintained to minimum erosion.

46. The disposal area and cover of the trenches shall be arranged and graded in such a manner that all surface runoff water shall be completely removed from the vicinity of the trenches.

47. Temporary trench boundary markers and trench identification markers shall be erected upon completion of backfill operations until permanent granite markers are installed.

Conditions - Site

48. All wells constructed at the site specified in Condition 5. of this license shall be protected from damage.

49. Interim or final grades shall be established and seeding of trench covers shall commence at no more than one year following final trench burial operations.

50. A series of granite markers, one at the end of each completed trench and on each corner, shall be erected upon completion of the seeding of trench covers. The following information shall be inscribed on the end monument, and this information shall be reported to the Chief, Bureau of Radiological Health, South Carolina Department of Health and Environmental Control, 2600 Bull Street, Columbia, South Carolina 29201.

    a. Total activity of radioactive material in curies excluding source and special nuclear materials, total amount of source material in pounds, and total amount of special nuclear material in grams in the trench.

    b. Date of completion of the burial operations; and

    c. Volume of waste in the trench.

51. The licensee may not exhume previously buried waste.

52. As material buried may not be transferred by abandonment or otherwise, unless specifically authorized by the Department, the expiration date on this license applies only to the above ground activities and to authority to bury radioactive material wastes at the site specified in Condition No. 5. The license continues in effect and the responsibility and authority for possession of buried radioactive material wastes continues until the Department finds that the plan established for preparation of the Barnwell site for transfer to another person has been satisfactorily implemented in a manner to reasonably assure protection of the public health and safety and the Department takes action to terminate your responsibility and authority under this license. All requirements for environmental monitoring, site inspection, and maintenance, and site security continue whether wastes are being buried or not.

53. Site closure and stabilization of the licensee's facility shall be accomplished in accordance with the U. S. Nuclear Regulatory Commission's Low-Level Waste Branch Position entitled, "Low-Level Waste Burial Ground Site Closure and Stabilization," Revision 1 dated May 17, 1979. A copy of the performance objectives is attached.

Conditions - Site

54. Prior to May 31, 1980, a preliminary plan for preparation of the site for transfer to another person who would only passively hold the site shall be submitted for review. The plan shall be consistent with Condition 53. of this license and shall include demonstration that funds are being set aside or other measures being taken are adequate to finance the site closure plan. The plan shall also include preliminary estimates of costs, environmental impacts, data needs, personnel needs, material and equipment needs, planned documentation and quality assurance, and detailed plan for trench locations and elevations, expected capacities, planned surface contours, and buffer zones.

55. Prior to May 31, 1980, a reassessment of current operating practices shall be submitted. The reassessment shall consider the objectives of the site plan specified in the preceding paragraph and any changes in operation at the site which would enhance implementation of the plan.

56. The licensee shall submit an updated plan and operational assessment every five years for review.

57. One year prior to the anticipated transfer of the site and buried radioactive materials to another person (including an agency of the U.S. Government) the licensee shall submit a final version of the site preparation plan including a schedule for implementation of all remaining plan elements prior to transfer, and a description of the mechanics of orderly transfer in coordination with the transferee.

58. Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Condition 20. of this license in accordance with statements, representations, procedures, and site criteria, heretofore made by the licensee in application for and subsequent to the issuance of S. C. Radioactive Material License No. 097, and amendment thereto.

For The South Carolina Department
of Health and Environmental Control

Date of Issuance October 30, 1978 BY: Howard G. Sheely
Howard G. Sheely, Chief
Bureau of Radiological Health

## APPENDIX A-3, SITE VISIT TO RICHLAND-NECO

The NECO site at Richland is located close to the 200E area of the Hanford Reservation. The surrounding countryside is semi-arid steppe of low population density. The Hanford Reservation is a large land area where access is very restricted and under Government control.

The site is on a 100-acre parcel which is leased from the State of Washington. The ten-acre parcel is part of a 1000-acre parcel leased from the Federal Government by the State of Washington. The site manager estimates a 20-year capacity of the 100 acres; currently about three acres have been used for burial. As of December, 1979, they are filling the sixth trench.

Because of difficulties with leaking loads received at the site, it was closed by the state governor on October 4, 1979. Subsequently, the site was reopened November 19, 1979, and is currently operating with full-time state and NRC inspectors at the site.

Trench construction is by dragline crane which has the disadvantage of piling up earth on both sides of the trench leaving only the trench ends for a working area. Trenches used to be constructed as they were filled (digging 30-45 meters ahead of the waste); currently they dig an entire trench before commencing to fill. It typically takes six to eight weeks to dig a trench. In contrast to the DOE site (only a few kilometers away), it is possible to dig trenches with straight sides without collapse. Soil slumping occurring at approximately $45^{o}$ does not permit straight sides at the DOE site. The dimensions of the trenches are 7.5 meters deep, 25 meters wide, and 137 meters long with some variance in length. The dimensions of trenches are the responsibility of the site manager who determines what the trench size will be within the license specifications.

Waste is covered as necessary to maintain doses below 100 mr/hr; levels are normally less than five mr/hr. Waste is emplaced in the trench up to 0.9 meters below the natural ground level. All waste (boxes and barrels) is placed by crane (no dumping). It is then covered with a soil cap which is 1.5 meters thick at the center and 0.9 meters thick at the edges. NECO's new license will

require a 9-meter cap for items exceeding 10 R/hr. There is an unburied possession limit of 6000 Ci.

High-intensity loads are occasionally received at the site. Unlike Barnwell, they do not use a special trench or a permanently-shielded facility. Unloading procedures are tailored to individual needs of a load and worked out before the load arrives. The high-intensity material is emplaced in the same trench as all other waste. Other waste and earth are used as shielding around high-intensity material. Once emplaced, this material is immediately covered. An example of the operation was a recent shipment of reactor poison curtains with a surface reading of 8000 to 10,000 R/hr. A temporary shielded compartment was formed by burying a section of culvert in the ground. The load was then lowered into this shadow shield so that the cask could be opened and hoisted out by crane. Wooden boxes filled with zirconium extraction residues from Teledyne Wah Chang were used for shielding around the cask in the trench. Large quantities of these boxes are regularly received as waste at the site. The material is a high-density sand with an extremely low level of radiation.

Health physics activities include constant radiation monitoring during operations (unloading and replacement), personnel dosimeter (pencils and monthly film badges), and constant air sampling counted every 24 hours except weekends when the site is normally shut down. NECO depends on the DOE environmental monitoring program for indications of nuclide transport problems. There are no sample wells at the site but much water, soil, and vegetation sampling is performed in an extensive program on the Hanford Reservation. In addition, there is extensive atmospheric monitoring on the reservation. Personnel are monitored by bioassay and whole body counting every six months. The state of Washington places TLD's on the four corners of the site boundary which are collected and counted monthly. No dose above background has ever been detected by the TLD's.

A wide variety of waste types is received at the site. Liquid wastes as free liquids are only accepted as scintillation vials. Other liquids are accepted only if sorbed and properly packaged. There are no special packaging facilities at the site but they occasionally overpack items which are leaking or suspect. Overpacking is generally done with plastic bags or large drums (such as 300-liter size to overpack 210-liter drums). DOT standards are observed for package acceptance and vehicle release. Vehicles are surveyed and spot smeared. The site is currently accepting TRU waste with fissile limits as follows:

| | | | |
|---|---|---|---|
| Pu | 530 g/m$^3$ | U-235 | 530 g/m$^3$ |
| | 60 g/container | | 100 g/container |
| | 300 g/shipment | | 500 g/shipment |

As of February 29, 1980, they will receive no TRU exceeding the 10 nCi/g limit (current limit at all other sites). There are currently no restrictions on the geographic source of the wastes; it was stated that one of NECO-Richland's largest customers is on the "east coast."

The following information is attached to this appendix: *

- Instructions to shipper on packaging of vials, animal carcasses, and free liquids.
- Price list for disposal.
- Sample of shipping form used.

*Note that much of this material also pertains to the Beatty site.

Nuclear Engineering Company, Inc.
9200 SHELBYVILLE ROAD, SUITE 526 · P O BOX 7246
LOUISVILLE, KENTUCKY 40207 PHONE (502) 426-7160

August 31, 1979

PACKAGING INSTRUCTIONS

Gentlemen:

Effective October 1, 1979, all absorbed liquid, scintillation vials and/or animal carcasses must be packaged in the manner outlined on the attached sheets. Please be advised that these are the minimum requirements.

The procedure for packaging animal carcasses parallels ANSI Standard N 14.3, "Packaging and Transportation of Radioactively Contaminated Biological Materials"

You are cautioned that mixing of radioactive waste types within a single container is not permitted.

Should you have any questions, please do not hesitate to call.

Sincerely yours,

Alice M. Spann

Alice M. Spann
Assistant Manager, Radioactive Sales

AMS:ck

# WASHINGTON AND NEVADA NUCLEAR CENTERS
# PACKAGING SCINTILLATION VIALS

1. CONTAINER MUST BE DOT APPROVED 17H DRUM EITHER 30 OR 55 GALLON.
2. CONTAINER MUST BE LINED WITH A 4 MIL PLASTIC LINER AND SEALED AT THE TOP WHEN CONTAINER IS PACKED.
3. PLACE APPROXIMATELY 3" OF ABSORBENT AT THE BOTTOM OF THE CONTAINER. VIALS AND ABSORBENT MUST BE PLACED IN THE CONTAINER IN LAYERS NOT EXCEEDING 6" IN DEPTH. BETWEEN EACH LAYER AT LEAST 1" OF ABSORBENT MUST BE PLACED. THE TOP LAYER MUST BE APPROXIMATELY 3" OF ABSORBENT.
4. THE VIALS ARE NOT TO BE OPENED.
5. THE CONTAINER MUST BE FILLED WITH A TWO-TO-ONE RATIO OF ABSORBENT TO LIQUID IN THE VIALS.
6. APPROVED ABSORBENTS ARE:

   PERLITE (MEDIUM GRADE)
   DIATOMACEUS EARTH (MEDIUM GRADE)
   SUPER FINE (DIATOMITE)
   SPEEDI DRY

## WASHINGTON AND NEVADA NUCLEAR CENTERS
## PACKAGING ANIMAL CARCASSES

1. Container must be a DOT approved double wall 30 Gallon size inside 55 Gallon.
2. Line 30 Gallon drum with 4 mil plastic liner.
3. Place animal carcasses into 30 Gallon drum with absorbent and lime. Ratio: One part lime to ten parts absorbent.
4. Seal Plastic Liner & 30 Gallon drum.
5. Place inside 55 Gallon drum.
6. Place absorbent between walls of 30 Gallon drum and 55 Gallon drum.
7. Seal 55 Gallon drum.
8. Approved Absorbents are:

   Perlite (Medium Grade)
   Diatomaceus Earth (Medium Grade)
   Super Fine (Diamote)
   Speedi Dry



10/1/79

## WASHINGTON NUCLEAR CENTER (ONLY)

## PACKAGING ABSORBED LIQUIDS

1. CONTAINER MUST BE A DOT APPROVED 17H DRUM EITHER 30 GALLON OR 55 GALLON.
2. CONTAINER MUST BE LINED WITH A 4 MIL PLASTIC LINER AND SEALED AT THE TOP WHEN CONTAINER IS PACKED.
3. CONTAINER MUST BE FILLED WITH A TWO-TO-ONE RATIO OF ABSORBENT TO LIQUID LAYERED IN APPROXIMATELY ONE FOOT LAYERS TO ENSURE EVEN DISPERSION.
4. APPROVED ABSORBENTS ARE:

   PERLITE (MEDIUM GRADE)
   DIATOMACEUS EARTH (MEDIUM GRADE)
   PEL-E-CEL
   SUPER FINE (DIATOMITE)
   SPEEDI DRY

Nuclear Engineering Company, Inc.
3200 SHELBYVILLE ROAD, SUITE 526 • P.O. BOX 7246
LOUISVILLE, KENTUCKY 40207 PHONE (502) 426-7160

September 14, 1979

Dear Customer:

Enclosed is Nuclear Engineering Company, Inc.'s (NECO) new price list which sets forth specific increases for disposal services. As you can appreciate, the cost to operate radioactive waste disposal sites and to provide related professional services has continued to increase at a rapid rate.

NECO has absorbed the increase in operating costs for the past 15 months; however, NECO can no longer continue to do so. Accordingly, you are notified that the enclosed price list will be effective October 15, 1979. In the event that there are specific contractual provisions between your Company and NECO regarding pricing, you are hereby notified that the enclosed price increase, applicable to services performed by NECO for your company, will be effective pursuant to the applicable contract provisions. Therefore, this letter constitutes written notice as required by our agreements.

We appreciate your business and look forward to a mutually satisfactory arrangement.

Very truly yours,

Arvil Crase

Arvil Crase
Director of Marketing

AC:thw

Enclosure

# NUCLEAR ENGINEERING COMPANY, INC.

## WASHINGTON NUCLEAR CENTER AND NEVADA NUCLEAR CENTER

## SCHEDULE OF CHARGES
## RADIOACTIVE WASTE

1. Disposal Charges

   A. Solid Material

   Steel Drums, Wood Boxes, Liners:

| R/HR AT CONTAINER SURFACE | PRICE PER CU. FT. |
|---|---|
| 0.00 - 0.20 | $ 5.75 |
| 0.201 - 1.00 | 6.30 |
| 1.01 - 2.00 | 7.05 |
| 2.01 - 5.00 | 8.60 |
| 5.01 - 10.00 | 10.15 |
| 10.01 - 20.00 | 13.15 |
| 20.01 - 40.00 | 16.75 |
| 40.01 - 60.00 | 24.95 |
| 60.01 - 80.00 | 30.10 |
| 80.01 - 100.00 | 33.05 |
| Over 100.00 | By Request |

   Disposable Liners Removed From Shield:

| R/HR AT CONTAINER SURFACE | SURCHARGE PER LINER | PRICE PER CU. FT. |
|---|---|---|
| 0.00 - 0.20 | No Charge | $ 5.75 |
| 0.201 - 1.00 | $ 78.65 | 5.75 |
| 1.01 - 2.00 | 193.60 | 5.75 |
| 2.01 - 5.00 | 272.25 | 5.75 |
| 5.01 - 10.00 | 393.25 | 5.75 |
| 10.01 - 20.00 | 502.15 | 5.75 |
| 20.01 - 40.00 | 623.15 | 5.75 |
| 40.01 - 60.00 | 738.10 | 5.75 |
| 60.01 - 80.00 | 853.05 | 5.75 |
| 80.01 - 100.00 | 968.00 | 5.75 |
| Over 100.00 | By Request | By Request |

   B. Scintillation Vials $7.90/cu.ft.

   C. Biological Waste $6.50/cu.ft.

2. Disposal Charges - Transuranic Material - By Request (Washington Only)

3. Surcharge For Heavy Objects:

| | |
|---|---|
| Less than 10,000 pounds | No Charge |
| 10,001 pounds to Capacity of Site Equipment | $ 60.00 plus $.01 per lb. above 10,000 lbs. |

4. Surcharge For Curies (Per Load):

| | |
|---|---|
| Less than 100 curies | No Charge |
| 101 - 300 curies | $ 455.00 |
| 301 - License Limits | $ 455.00 plus $.06 per curie |

5. Minimum Charge Per Shipment: $ 180.00

6. Cask Handling Fee: $ 300.00 minimum each

SCHEDULE OF CHARGES

Page 2

| | |
|---|---|
| Unirradiated Special Nuclear Materials, subject to license limits: | By Request |
| Irradiated Special Nuclear Materials, subject to license limits: | By Request |
| Surcharge for non-routine man-Rem exposure (due to design or physical defect of container or shield): | $ 8.50 per man millirem |
| Decontamination Services (if required) | $30.00 per man'hour plus supplie at cost plus 15% |

1. Container Volumes:

55 Gallon Drums - 7.50 cu. ft.
30 Gallon Drums - 4.01 cu. ft.
5 Gallon Drums - 0.67 cu. ft.

rices Effective October 15, 1979

ICN Life Sciences
Health Physics Services
2727 Campus Drive, Irvine, Calif. 92664
Telephone: 714 833-2500
California License No. 1132-59

HS-10
10/75

01777

Date _____

P.O. No. _____

# RADIOACTIVE WASTE SHIPMENT RECORD

Page _____ of _____ Pages

Received From: _____ License Number: _____

Street Address: _____

City and State: _____ Zip Code: _____

| ITEM NO. | | | | RADIATION, (mR/hr.) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CUST. NO. | HPS NO. | VOLUME (CU. FT.) | PHYSICAL STATE | AT SURFACE | AT ONE METER | ISOTOPE | TRANSPORT GROUP | BY-PRODUCT (mCi) | SOURCE (LB) OR SNM (GRMS) |
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**TOTALS:**

By-Product _____ mCi
Source Material _____ lb
Special Nuclear Material _____ g
Remarks: _____

**SHIPPER'S CERTIFICATION:**

Contents of these packages are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. In particular, containers have less than 2200 dpm (β-γ), and/or 220 dpm (α) per 100 $cm^2$ removable contamination.

**CERTIFIED TRUE:**

By _____
SIGNATURE AND TITLE

**HEALTH PHYSICS SERVICES**

**SURVEYED BY:**

Signature: _____

**FOR OFFICIAL USE ONLY:**
**Final Disposition**

Date _____

Location _____

Remarks: _____

## APPENDIX A-4, SITE VISIT TO RICHLAND-DOE SITE

The Richland-DOE burial ground is located in the 200W area on the Hanford Reservation. The reservation is a large Federal Government controlled area in eastern Washington State where the countryside is typical semi-arid, northern steppe. Areas surrounding the reservation are generally of low population density. The area is typified by low rainfall and very deep aquifers 70-90 meters below the surface. The main runoff paths for surface water converge on the nearby Columbia River which is at about 160 meters above sea level and is the watertable level determining factor. The site is at about 230 meters above sea level so that the watertable is about 60 to 70 meters below the site.

Approximately 180 to 200 acres have been used to bury 200,000 $m^3$ of waste at this site over the last 40 years. During FY 1978 10,200 $m^3$ of waste was buried in comparison to 4000 $m^3$ of waste buried in the first two months of FY 1980. A large increase is expected in the near future.

Various disposal methods tailored to different types of waste are used at the site. In the past, fission products and TRU wastes were not sorted but were dumped together in "V" trenches which were about six meters deep. Since 1970, TRU wastes have been segregated and buried in trenches as retrievable material (contained in drums or FRP boxes neatly stacked with plywood separators and covered with plastic before dirt is placed over the top). A retrieval period of 20 years is envisioned. High dose rate materials have been dumped into caissons (Figure A-4) consisting of buried compartments with chutes down which barrels or cans of waste are dumped. Significant difficulties (such as clogged chutes) have been encountered in such operation and abandonment of the method is being considered. Additional concern is caused by the difficulty of retrieval of caisson waste. Mixed fission product waste is usually dumped into V-shaped trenches by dump truck. This waste is covered daily to prevent spread of contamination.

Radiation monitors are always present during dumping operations. Hanford environmental monitoring of the reservation is extensive and includes monitoring of water, air, flora, and fauna. One unique feature not present at

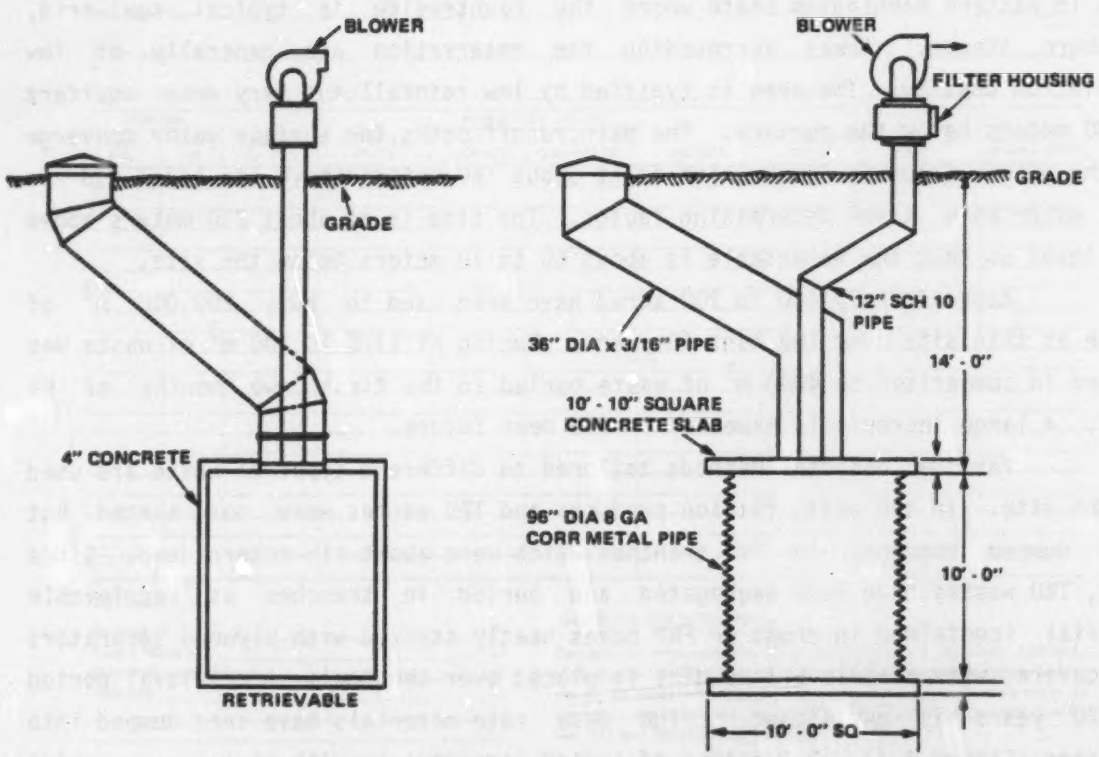


Figure A-4. Solid Waste Burial Caissons.

commercial sites is the use of regulated trenches. These trenches are not decontaminated; it is understood that they carry a certain amount of contamination routinely. Regulated trenches are confined to the reservation and restricted to specific routes.

Various limits adhered to in the operation are:

- Less than 24 km/h wind velocity for mixed fission product dumping.
- 200 mR/h dose limit on drums.
- One $pCi/cm^2$ alpha smear on drums (spot smear testing).
- Less than 200 grams Pu in drum (criticality safety).

## APPENDIX A-5, SITE VISIT TO BEATTY, NEVADA

The Beatty site is the oldest commercial burial location and handles approximately eight percent of the national LLW volume. It has been operated by Nuclear Engineering Company (NECO) since 1962 and is located 32 kilometers south of the town of Beatty, Nevada. The site is located close to the DOE Nevada Test Site in a dry, sparsely-populated region of the State of Nevada, approximately 240 kilometers north of Las Vegas. The total site area is approximately 80 acres and is leased from the State of Nevada, the legal entity with ultimate responsibility for the site after it closes.

### A-5.1 GENERAL DESCRIPTION

The layout of the burial ground is shown in Figure A-5. The LLW trench area is 52 acres, a hazardous chemical waste area is approximately 16 acres, and a buffer between the two operations consists of 12 acres. Within the LLW area, three sets of trenches have been dug. The first set was used from the opening of the site in 1962 until 1965, and is approximately six meters deep. The next set, operated from the mid-sixties until the early seventies, is longer and approximately nine meters in depth. The trenches which are currently being dug and filled are 245 meters long, 37 meters wide, and 15 meters deep. Plans are under way to increase the depth by three meters in future trenches. Each trench takes approximately three to four months to dig and one-and-a-half to two years to fill. At present, only 60 percent of the site is filled. It is anticipated that operations will go on for a significant time.

The site is located on an alluvial plain draining to the south-southeast direction away from the town of Beatty. The average annual precipitation is 75 to 130 mm, the evaporation rate is 2.87 meters, and the watertable is approximately 107 meters below the surface. The surface soil layer of the site consists of 0.3 to 1.2 meters of gravel and interstitial clay underlain by a 43-meter thick layer of impervious clay ($10^{-6}$ to $10^{-9}$ cm/sec permeability). A well 150 meters deep is located at the site for sampling

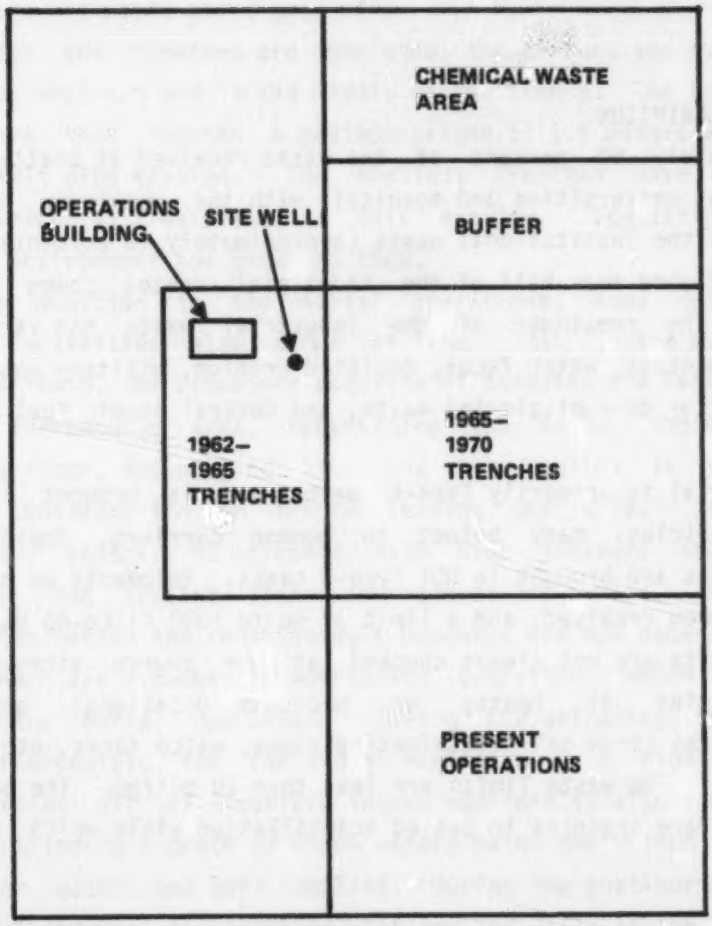


Figure A-5. Layout of the Beatty Site (no scale)

purposes. The nearest surface water is the Amargosa River, which runs from the north of Beatty and then juts west and southeast of the site. There are no direct surface drainage channels near the burial ground. High winds of up to 100 km/h and some dust devils occur at the site; the wind has blown spoils piles over the trenches.

## A-5.2. WASTE DESCRIPTION

Approximately 50 percent of the waste received at Beatty comes from institutions such as universities and hospitals with the remainder coming from industry. Most of the institutional waste (approximately 90 percent) is handled through brokers and more than half of the industrial wastes comes from three power reactors. The remainder of the industrial waste has varied origins including lantern mantles, watch faces, depleted uranium, military waste, the AI Santa Susannah Reactor decommissioning waste, and General Atomic Fuel Fabrication waste.

The material is primarily Type-A waste and is brought in standard tractor-trailer vehicles; many belong to common carriers. Small amounts of high-intensity wastes are brought in DOT Type-B casks. Shipments as high as 1400 Ci of Co-60 have been received, and a limit of up to 1600 Ci Co-60 equivalent is allowed. These limits are not always checked at the source sites. However, monitoring activities at Beatty do occur. Occasional shipments of tritium-bearing wastes (from self-illuminating signs, watch faces, etc.) may be as high as 1000 Ci. TRU waste limits are less than 10 nCi/gm. The only liquids allowed at the site are organics in sealed scintillation vials which are packed in 210-liter drums.

## A-5.3. SITE OPERATIONS

A total of nine employees work at the Beatty site including a health physicist, a radiation technician, and a radiation safety officer. On-site training of personnel also occurs. The highest dose in the preceeding year of operation was 900 mR. In general, annual doses do not exceed one R.

The emplacement of wastes occurs with a forklift or a crane which transfers the waste from the transport vehicle to the trench. Previously, it had been the practice at the site to manually roll the barrels down a ramp. However,

due to back injuries, this method of unloading has been suspended. The waste is stacked up to a height of 0.4 meters below the surface and is buried every Friday (the site license allows the material to be uncovered for up to 60 days). High intensity waste is covered immediately. In order to prevent theft, the burial operations are witnessed and signed off.

When the trenches are completed, the corners are surveyed and markers are placed at each end and in the middle of the trench. The trenches are covered with a crown that reaches a maximum height of 1.5 meters and are topped with gravel to limit wind erosion. The earliest trenches have formed a "desert pavement" which is resistant to this erosion. Vegetation similar to the surrounding environment now grows on them.

In addition to the burial operations, some decontamination and repackaging activities also occur at the site. In the event that a leaking container is found, the procedure consists of stopping the leak, cleaning up the truck and surrounding area, repackaging the waste, impounding the trailer, removing its floor, and burying it. The site policy is not to allow any detectable contamination on trucks leaving the site. If contamination is detected, the vehicle is cleaned with high pressure steam. If this is insufficient, the trailer floor is removed and buried. In nearly all cases, these decontamination and repackaging procedures are not necessary.

There are a number of monitoring activities which occur during all phases of the burial operation. During LLW unloading, the radiation safety officer is responsible for radiation monitoring. A high-volume particulate sampler running off of a vehicle intake manifold is also used. Four dry wells have been drilled to a depth of three meters below the trench for the purposes of checking for water and soil sampling. During the post-burial phase, there are also two environmental air sampling stations and wells at the site (150 meters deep) and at Lathrop Wells, a settlement downstream from the waste site.

## A-5.4. ABNORMAL INCIDENTS

During its 18-year history, a number of abnormal incidents have occurred. These include the following:

- Removal of contaminated salvageable tools, items, and equipment from the burial site.

- Use of a contaminated cement mixer for the pouring of concrete slabs for surrounding residences and public structures.
- Leaking shipments - a number of leaking shipments have been sent by Consumer's Power, and in one other instance, there was liquid dripping from the truck when it arrived at the site.
- Improper or missing labels.
- Poor marking of trenches resulting in the placement of the facility fence such that wastes were found on the outside.
- A fire caused by the presence of pyrophoric and flammable material on the same shipment.

As a result of these and other problems, the site has been closed by the state on several occasions. The NRC has plans for a full-time inspector at the site for a period of months.

# APPENDIX B

# ANNOTATED EVENTS LIST

## APPENDIX B, ANNOTATED PATHWAYS LIST

This appendix contains an annotated form of a pathways list developed during a group "brainstorming" session. The results of the session formed a basis from which individual pathways studies for various sites and for transportation/packaging were develcped. The list was generated without discussion -- the annotations have been added since.

PATHWAYS FOR RADIONUCLIDES -- BRAINSTORMING SESSION

B.1 Packaging (routine or probabilistic)

B.1.1 Package breach

- Drop
- Crush -- usually occurs after burial
- Spear/puncture -- can be a common problem
- Fire/explosion -- has occurred in past
- Improper seal -- problem at Beatty and Richland
- Corrosion -- especially metal drums
- Immersion
- Gas pressure -- seen at DOE site in Richland as "bulging"
- Internal heat
- Chemical attack -- similar to corrosion
- Sabotage -- highly improbable
- Mistaken label causing error
- Lack of label
- Elements -- many sites store waste outside
- Improper storage -- no standards
- overstress -- similar to dropping, etc.
- Defective container
- Vibration

B.1.2 Process accidents

- Overflow
- Spill
- Transport jam
- Contamination spread
- Mistaken disposal or negligence -- no way to characterize
- Criticality -- < 10nCi/gm standard helps

B.1.3 Process routine releases

- Leakage -- see contamination spread
- Off-gas -- largest problem

- Particulates -- see contamination spread
- Liquid effluents
- Contamination spread -- due to process mishaps
- Personnel -- theft of "useful" items
  - inadequate protection
  - regular labor

B.1.4 Process (other) -- see Beatty History

- Theft
- Scavenging
- Misuse of equipment

B.2 Transportation Routine

- Contamination -- trucks used for other cargo
- Allowable dose -- DOT standards
- Parking overnight } security problems
- Stopping points }
- Collisions -- most common problem but few releases
- Driver error
- Weather-related -- cause accidents
- Fire/explosion
- Loss of load
- Package breach during transport
- Hijacking -- due to mistake regarding load
- Wrong delivery -- what has been history?
- Leakage
- Stowaways -- direct exposure
- Sinking (barge)
- Derailing (train)
- Grounding (barge)
- Negligence (leaving behind-rail or truck)
- Sabotage } highly unlikely
- Criticality }

6.3 Burial Routine

- Trench water leaching -- water limited in dry areas
- Personnel exposure -- "shine"
- Crushing or compacting during fill -- happens routinely, waste not retrievable
- Normal weather-related release/dispersion
- Uncovered waste -- 60 days at some sites
- Receiving off-spec or hot loads (mislabeling) -- common problem
- Releases from on-site processing -- Maxey Flats
  - -- gaseous
  - -- liquid
- Package degradation
- Decontamination activities:
  - -- steam cleaning -- Beatty
  - -- sand blasting -- Barnwell
  - -- electropolish

B.4 Burial Accident

- Fire/explosion
- Sabotage
- Equipment failure
- Operator error
- Chemical explosions
- On-site truck accidents -- have occurred
  (See package breach)
- Procedure violations -- not too common now
- Scavenging
- Redigging trench due to mislocation -- Beatty trenches mislocated
- Equipment intrusion -- see redigging
- Quality control on inspection errors
- Animal tunneling -- most animals don't dig deep enough
- Animal intrusion

B.5 Long-Term Releases

- Uncovering due to boundary errors -- Beatty, early trenches
- Uplift
- Subsidence
- Erosion (water, wind) -- Beatty, wind; Barnwell, water
- Earthquake -- Beatty, fairly high probability, low effect
- Vegetation absorption and intrusion
- Animal absorption
- Other (tsunami, glacier, flood, volcano, meteor) -- very low probability
- Animal tunneling
- Human intervention
  - -- drilling
  - -- exploration
  - -- farming
  - -- residency
  - -- war
  - -- recreation
- Water leaching and transport -- principal mode in wet sites
- Gas transport -- some studies underway
- Domestic animal grazing above site -- plant absorption
- Faulting
- Release from on-site processing
  - -- gaseous
  - -- liquid
- Recovery

# APPENDIX C-1

# RELEASE SCENARIOS

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Arrival Phase (Pre-entry Inspection) | A-1<br>A ruptured drum with liquid substance causes spill to contaminate the vehicle or the overpack interior | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | A-2<br>A ruptured drum with volatile substance causes release to contaminate the vehicle or the overpack interior | WS-2<br>WS-3<br>WS-4 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | A-3<br>A ruptured drum, carton or box containing solids causes release to contaminate the vehicle or the overpack interior | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-1}$ | | | | |
| | A-4<br>Worker is injured by contaminated sharp object protruding from ruptured drum, carton or box during receiving inspection | WS-2<br>WS-3<br>WS-4 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | A-5<br>Fire erupts in the transport vehicle or in the overpack containing combustible carbons, boxes or loose bundles during receiving inspection. Fire is allowed to burn out | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2\times10^{-2}$ | | | | |
| | A-6<br>Fire erupts in the transport vehicle or in the overpack containing combustible cartons, boxes or loose bundles during receiving inspection. Fire is quenched with water | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | $10^{-1}$ | 2-4 | $2\times10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |
| | A-7<br>Explosion in the transport vehicle or in the overpack containing drums or boxes with volatile substances or liquid containers | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | A-8<br>Explosion in the transport vehicle or in the overpack containing drums, boxes or cartons filled with solids or loose bundles | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |
| | A-9<br>Irradiated/contaminated usable items are removed from wastes | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | A-10<br>Chronic direct radiation to workers engaged in the pre-entry inspection of drums, boxes, cartons and loose bundles | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | A-11<br>Chronic escape to atmosphere of radionuclides during the pre-entry inspection of drums, boxes, carbons and loose bundles | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-5}$ | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| On-site Handling and Emplacement in the Trench | B-1<br>Liner containing highly activated LWR components is accidently ruptured during transfer into the burial trench. Wastes are spilled from the liner | WS-1 | 3 | 1.0 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | |
| | B-2<br>Chronic direct radiation to workers engaged in removing the liner, containing highly activated LWR components from shielded cask and manipulating it into the burial trench | WS-1 | 3 | $10^{-6}$ | | | | | | |
| | B-3<br>Drum with liquid waste containers is ruptured during transfer from the transportation overpack to burial trench. Liquid is spilled into overpack | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | B-4<br>Drum with liquid waste containers is ruptured during transfer from the transportation overpack to burial trench. Liquid is spilled into trench | WS-2<br>WS-3<br>WS-4<br>WS-5 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | | | |
| | B-5<br>Drum contining volatile substance is ruptured during transfer from the transportation overpack to burial trench. Volatile substance escapes to atmosphere | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | 1.0 | | | | | | |
| | B-6<br>Drum, carbon or box containing solid substance is ruptured during transfer from the transportation overpack to burial trench | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-3}$ | 1-4 | $10^{-4}$ | | | | |
| | B-7<br>Fire erupts in the transportation overpack or in the trench containing combustible cartons, boxes, or loose bundles. Fire is allowed to burn out | WS-2<br>WS-3<br>WS-4<br>WS-5<br>WS-6 | 3 | 1.0 | 2-4 | $2x10^{-2}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | B-8<br>Fire erupts in the transportation overpack or in the trench containing combustible cartons, boxes or loose bundles. Fire is quenched with water | WS-2<br>WS-3<br>WS-4<br>WS-5<br>WS-6 | 3 | $10^{-1}$ | 2-4 | $2x10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2x10^{-5}$ |
| | B-9<br>Explosion in the transportation overpack or in the trench containing drums or boxes with volatile substances or liquid containers | WS-2<br>WS-3<br>WS-4<br>WS-5<br>WS-6 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2x10^{-5}$ |
| | B-10<br>Explosion in the transportation overpack or in the trench containing drums, boxes, carbons filled with solids or loose bundles | WS-2<br>WS-3<br>WS-4<br>WS-5<br>WS-6 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2x10^{-5}$ |
| | B-11<br>Chronic direct radiation to workers engaged in unloading of drums, boxes, carbons and loose bundles from the transportation overpack | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | B-12<br>Chronic escape to atmosphere of radionuclides during unloading of drums, boxes, cartons and loose bundles from the transportation overpacks | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-5}$ |
| | B-13<br>The transportation overpacks and/or vehicle inadequately decontaminated prior to release | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | B-14<br>Irradiated/contaminated usable items are removed from wastes during handling | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Waste in an Uncovered Trench | C-1<br>Fire erupts in the uncovered trench containing burnable cartons, boxes or loose bundles. Fire is allowed to burn out | WS-6 | 2-4 | $2 \times 10^{-2}$ | | | | | | |
| | C-2<br>Fire erupts in the uncovered trench containing burnable carbons, boxes or loose bundles. Fire is quenched with water | WS-6 | 2-4 | $2 \times 10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | |
| | C-3<br>Uncovered trench is flooded from rainfall | WS-6 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | | | |
| | C-4<br>High velocity wind causes lifting and dispersal of those radionuclides from the uncovered trench which are attached to dust, light powders, loose papers or boards, etc. The materials lifted from the trench are dispersed over the site | WS-6 | 3 | 1.0 | 2-4 | $2 \times 10^{-5}$ | | | | |
| | C-5<br>Irradiated/contaminated usable items are removed from wastes | WS-6 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | C-6<br>Animals (rats, rabbits, etc.) intrude into uncovered wastes, become contaminated, and carry radionuclides outside of the trench | WS-6 | 4 | $10^{-4}$ | | | | | | |
| | C-7<br>Chronic direct radiation to workers engaged in the activities in the vicinity of uncovered wastes | WS-6 | 3 | 1.0 | | | | | | |
| | C-8<br>Chronic escape to atmosphere of radionuclides from the uncovered wastes | WS-6 | 2-4 | $10^{-5}$ | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Waste Burial Backfill and Compaction | D-1<br>Liner containing highly activated LWR components is accidently ruptured during burial or backfill operation. Wastes are spilled from the liner | WS-1 | 3 | 1.0 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | |
| | D-2<br>Chronic direct radiation to workers engaged in burying the liner, containing highly activated LWR components | WS-1 | 3 | $10^{-6}$ | | | | | | |
| | D-3<br>Drum with liquid waste containers is ruptured during burial or backfill operation. Liquid is spilled into overpack | WS-6 | 3 | 1.0 | | | | | | |
| | D-4<br>Drum with liquid waste containers is ruptured during burial or backfill operation. Liquid is spilled into trench | WS-6 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | | | |
| | D-5<br>Drum containing volatile substance is ruptured during burial or backfill operation. Volatile substance escapes to atmosphere | WS-6 | 2-4 | 1.0 | | | | | | |
| | D-6<br>Drum, carbon or box containing solid wastes is ruptured during burial and backfill operation | WS-6 | 2-4 | $10^{-3}$ | | | | | | |
| | D-7<br>Fire erupts in the trench containing burnable carbons, boxes or loose bundles during burial and backfill operations. Fire is allowed to burn out | WS-6 | 2-4 | $2x10^{-2}$ | | | | | | |
| | D-8<br>Fire erupts in the trench containing burnable carbons, boxes or loose bundles during burial and backfill operations. Fire is quenched with water | WS-6 | 2-4 | $2x10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2x10^{-5}$ | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | D-9<br>Explosion in the trench containing drums or boxes with volatile substances or liquid containers during backfill operations | WS-6 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |
| | D-10<br>Explosion in the trench containing drums, boxes, cartons or loose bundles (in solid state) during burial and backfill operations | WS-6 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |
| | D-11<br>Chronic direct radiation to workers engaged in burial and backfill operations | WS-6 | 3 | 1.0 | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Maintenance of covered Trenches During Post-Burial Administrative con-period <100 years | E-1<br>Erosion or washing out of backfill inadequate backfill depth | WS-6 | 9-5-2-4 | $3x10^{-3}$ | 1-4 | $10^{-4}$ | | | | |
| | E-2<br>Intrusion of surface water, water seepage to water table through buried wastes | WS-6 | 9-1-4 | $10^{-1}$ | | | | | | |
| | E-3<br>Intrusion by scavengers (site worker/ outside person). Removal of contaminated items | WS-6 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | E-4<br>Intrusion by animals (rats, rabbits, etc.). Animals become contaminated | WS-6 | 4 | $10^{-4}$ | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Post-burial Unrestricted use Period >100 years | F-1 Erosion or washing out of backfill. Inadequate backfill depth | WS-6 | 9-5-2-4 | $3x10^{-3}$ | 1-4 | $10^{-4}$ | | | | |
| | F-2 Intrusion of surface water. Water seepage to water table through buried wastes | WS-6 | 9-1-4 | $10^{-1}$ | | | | | | |
| | F-3 Intrusion by scavengers digging for airtifacts. Removal of contaminated items | WS-6 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | F-4 Farming of the burial site for crops | WS-6 | 9-4 | $3x10^{-3}$ | | | | | | |
| | F-5 Use of the burial site as a pasture for domestic animals | WS-6 | 9-4 | $3x10^{-3}$ | | | | | | |
| | F-6 Intrusion by animals. Animals become contaminated | WS-6 | 4 | $10^{-6}$ | | | | | | |
| | F-7 Long-term flooding of the burial site | WS-6 | 9-5-2-4 | $10^{-1}$ | 1-4 | $3x10^{-7}$ | | | | |
| | F-8 Uncovering of the buried waste by earthquake | WS-6 | 3 | 1.0 | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Packaging at waste originators location or, processing and packaging at waste processing plant. | P-1<br>Highly activated LWR components are mishandled during packaging into a shielded cask, causing workers exposure. | WS-1 | 3 | 1.0 | | | | | | |
| | P-2<br>Chronic direct radiation to workers engaged in packaging highly activated LWR components into shielded casks. | WS-1 | 3 | 1.0 | | | | | | |
| | P-3<br>Liquid waste containers are ruptured during packaging, liquid is spilled. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | P-4<br>Container with volatile substance is ruptured during packaging. Volatile substance escapes to atmosphere. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | 1.0 | | | | | | |
| | P-5<br>Solid wastes are spilled and dispersed during packaging. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | |
| | P-6<br>Fire erupts during packaging of combustible wastes. Fire is allowed to burn out. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2 \times 10^{-2}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | P-7<br>Fire erupts during packaging of comubstible wastes. Fire is quenched with water. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2 \times 10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2 \times 10^{-5}$ |
| | P-8<br>Explosion during packaging of volatile substances or liquid. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2 \times 10^{-5}$ |
| | P-9<br>Explosion during packaging of solid wastes. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $2 \times 10^{-5}$ |
| | P-10<br>Chronic direct radiation to workers engaged in packaging or wastes or processing. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | P-11<br>Chronic discharge to atmosphere of radionuclides from facility off-gas stack during packaging/processing of wastes. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-3}$ | | | | | | |
| | P-12<br>Chronic discharge to atmosphere of radionuclides during incineration of wastes. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-6}$ | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | P-13<br>Discharge of radionuclides through off-gas stack with failed filters during packaging/ processing of wastes | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-6}$ | | | | | | |
| | P-14<br>Discharge of radionuclides through off-gas system with foilel filters during waste incineration | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-3}$ | | | | | | |
| | P-15<br>The package containing wastes inadequately decontaminated prior to release to shipment | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | P-16<br>Irradiated/contaminated usable items are removed from wastes during packaging or processing | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | P-17<br>Worker is injured by contaminated sharp object during packaging or processing | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Interim handling and storage at Originator or Broker. | S-1<br>A ruptured container with liquid substance causes spill to contaminate the storage or handling area. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | S-2<br>A ruptured container with volatile substance causes release to contaminate the handling or storage area. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | S-3<br>A ruptured drum, carton or box containing solids causes release to contaminate the handling or storage area. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-1}$ | | | | |
| | S-4<br>Worker is injured by contaminated sharp object protruding from ruptured drum, carton or box during interim handling or storage area. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | S-5<br>Fire erupts in the handling or storage area containing combustible cartons, boxes or loose bundles. Fire is allowed to burn out. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2x10^{-2}$ | | | | |
| | S-6<br>Fire erupts in the handling or storage area containing combustible cartons, boxes or loose bundles. Fire is quenched with water. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2x10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | S-7<br>Explosion in the handling or storage area containing drums or boxes with volatile substances or liquid containers. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |
| | S-8<br>Explosion in the handling or storage area containing drums, boxes or cartons filled with solids or loose bundles. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |
| | S-9<br>Irradiated/contaminated usable items are removed from wastes. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | S-10<br>Chronic direct radiation to workers engaged in the handling and storage of drums, boxes, cartons and loose bundles. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | S-11<br>Chronic escape to atmosphere of radionuclides during the handling and storage of drums, boxes, cartons and loose bundles. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-9}$ | | | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Waste transportation | T-1<br>Chronic direct radiation to workers engaged in the loading of drums, boxes, cartons and loose bundles on transport vehicles. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | | | | | | |
| | T-2<br>Chronic escape to atmosphere of radionuclides during the inspection prior to loading on transport vehicle of drums, boxes, cartons and loose bundles. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-5}$ | | | | | | |
| | T-3<br>Irradiated/contaminated usable items are removed from wastes during loading on transport vehicle. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| Waste transportation. | T-4<br>A ruptured drum with liquid substance causes spill to contaminate the vehicle or the overpack interior | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | T-5<br>A ruptured drum with volatile substance causes release to contaminate the vehicle or the overpack interior. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | T-6<br>A ruptured drum, carton or box containing solids causes release to contaminate the vehicle or overpack interior | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-1}$ | | | | |
| | T-7<br>Worker is injured by contaminated sharp object protruding from ruptured drum, carton or box during receiving inspection | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |
| | T-8<br>Fire erupts in the transport vehicle or in the overpack containing combustible cartons, boxes or loose bundles along transportation route. Fire is allowed to burn out. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2 \times 10^{-2}$ | | | | |
| | T-9<br>Fire erupts in the transport vehicle or in the overpack containing combustible cartons, boxes or loose bundles along transportation route. Fire is quenched with water. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | $10^{-1}$ | 2-4 | $2 \times 10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | T-10<br>Explosion in the transport vehicle or in the overpack containing drums or boxes with volatile substances or liquid containers | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |
| | T-11<br>Explosion in the transport vehicle or in the overpack containing drums, boxes or cartons filled with solids or loose bundles | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $10^{-3}$ | | | | |
| | T-12<br>A transport vehicle is abandoned or destroyed during transit. Liquid substance is spilled from damaged containers onto the roadway. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ |
| | T-13<br>A transport vehicle is damaged or destroyed during transit. Volatile substance is spilled from damaged containers onto the roadway. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 2-4 | $10^{-3}$ | | | | | | |
| | T-14<br>A transport vehicle is damaged or destroyed during transit. Solid or liquid wastes spilled on the roadway are flooded by rainfall. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 9-5-2-4 | $10^{-1}$ | 1-4 | $10^{-4}$ | | | | |

| ACTIVITY PHASE | SEQUENCE OF EVENTS LEADING TO RELEASE | SOURCE TERMS | PATH 1 | | PATH 2 | | PATH 3 | | PATH 4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF | PROGRAM | RF |
| | T-15<br>A transport vehicle is damaged or destroyed during transit. Solid waste is spilled on the roadway. High velocity wind causes lifting and dispersal of those radionuclides which are attached to dust, light powders, loose papers or boards, etc. The materials are dispersed over the roadway and neighboring countryside. | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 2-4 | $2 \times 10^{-5}$ | | | | |
| | T-16<br>Irradiated/contaminated items are removed from waste scattered as a result of transport vehicle damage or destruction | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-2}$ | | | | |
| | T-17<br>A worker is injured by contaminated sharp object protruding from ruptured waste container during post-accident cleanup of the roadway | WS-2<br>WS-3<br>WS-4<br>WS-5 | 3 | 1.0 | 4 | $10^{-3}$ | | | | |

# APPENDIX C-2

# DETAILED EVENT MATRICES

The equivalence between the Rasmussen style event trees and the event sequence tables developed for this study was described in Subsection 5.2.

The elements of the event tree matrix from which the representative scenarios were derived are summarized in Tables C.2-1 through C.2-7.

| | |
|---|---|
| Activity Phase | Table C.2-1 |
| Initiating Events | Table C.2-2 |
| Package Type | Table C.2-3 |
| Properties of Waste | Table C.2-4 |
| Vehicle Condition/Status | Table C.2-5 |
| Source Categories of LLWs | Table C.2-6 |
| Entry Pathways | Table C.2-7 |

The analysis was performed for each phase of the on-site activities discussed in Subsection 5.1 and listed in Table C.2-1. The Initiating Events (IEs) summarized in Table C.2-2 are the starting point for the event sequences that result in chronic or accidental releases. For each activity phase, they are sequentially combined with each type of packaging, or with the combination of packages as appropriate to the event, and with the physical properties of the contained wastes to determine whether a release could or could not occur as the result of the event. For the sequences resulting in the release, the pathways which are entered by the radionuclides and will subsequently produce the dose to the workers or the public are identified. The events with similar consequences are combined into categories represented by a dominant or representative release scenario which are summarized in Appendix C-1.

Table C.2-1. Activity Phases at Burial Site.

1. Vehicle Arrival and Pre-Entry Inspection
2. On-site Cargo Handling (Vehicle Transit to the Trench and Waste Emplacement)
3. Uncovered Wastes
4. Waste Burial (Backfill and Compaction)
5. Maintenance of Covered Trenches

Table C.2-2. Initiating Events.

| Descriptors | Identifiers |
|---|---|
| **Chronic Releases** | |
| Chronic Release of Direct Radiation | EI-1 |
| Chronic Release of Radionuclides to Atmosphere | EI-2 |
| Chronic Contamination | EI-3 |
| **Natural Events** | |
| Rain/Flood | EI-4 |
| Wind | EI-5 |
| **Operational Events** | |
| Container Rupture | EI-6 |
| Waste Spill | EI-7 |
| Waste Fire | EI-8 |

| | |
|---|---|
| Waste Explosion | EI-9 |
| **Intrusion Events** | |
| Theft of Usable Items | EI-10 |
| Animal Intrusion | EI-11 |
| Human Intrusion | EI-12 |

Table C.2-3. Package Type.

| Descriptors | Identifiers |
|---|---|
| Cask with Liner | CT-1 |
| Overpack | CT-2 |
| Liners | CT-3 |
| Drums | CT-4 |
| Boxes or Cartons | CT-5 |
| Uncontained | CT-6 |

Table C.2-4. Properties of Waste.

| Descriptors | Identifiers |
|---|---|
| Solid | CS-1 |
| Liquid | CS-2 |
| Volatile Vapors or Gases | CS-3 |
| Soluable | CS-4 |
| Combustible | CS-5 |
| Wind Dispersable | CS-6 |

Table C.2-5. Vehicle Condition/Status.

| Descriptors | Identifiers |
|---|---|
| Vehicle Exterior Contaminated | VS-1 |
| Vehicle Interior Contaminated | VS-2 |

Table C.2-6. Source Categories of LLW.

| Descriptors | Identifiers |
|---|---|
| Highly Activated LWR Components | WS-1 |
| LWR Operational Wastes | WS-2 |
| LWR Components from Reactor Decommissioning | WS-3 |
| Decontamination Wastes from Reactor Decommissioning | WS-4 |
| Institutional Wastes | WS-5 |
| Heterogeneous Wastes in Trenches | WS-6 |

Table C.2-7. Pathways Analysis Programs.

| Descriptors | Identifiers |
|---|---|
| Aquifer Transport | (AQUIFR) - (1) |
| Atmospheric Transport | (ATMOS) - (2) |
| Waste Radiation (Shine) | (DIRECT) - (3) |
| Waste Contamination | (DOSE) - (4) |
| Erosion | (ERODE) - (5) |
| Unsaturated Zone Water Transport | (UNSAT) - (9) |

An illustration of the development of scenarios using event matrices are shown in Figures C.2-1 through C.2-7. This example pertains to the burial site activity associated with waste emplacement in the trench. Figure C.2-1 represents the complete event matrix of sequences resulting from initiating event of container rupture or waste spill. The activity phase and type of waste and packages which are being analyzed are identified at the top of the table. After the event matrix is structured, each sequence is examined for logical combinations, and if appropriate, the corresponding scenario is recorded. For brevity, the scenarios in Figure C.2-1 are identified by an alphanumeric symbol which also corresponds to the descriptors in Appendix C-2. As can be seen in Figure C.2-1, a complete event matrix contains many illogical or insignificant combinations. A corresponding, reduced matrix from which these illogical sequences are eliminated is shown in Figure C.2-2. Figures C.2-3 and C.2-4 show reduced event matrices for fires and explosions. Figures C.2-5 through C.2-7 are included for completeness, to indicate that the particular initiating events are not applicable to this phase of activity, or are unnecessary duplications of scenarios considered elsewhere.

Activity Phase – On Site Handling and Emplacement
Packages – Drums, Cartons, Boxes
Waste Types – WS–2, WS–3, WS–4, WS–5

INITIATING EVENT – CONTAINER RUPTURE OR WASTE SPILL

| | Container Rupture | Solid | Liquid | Volatile Vapors | Soluble | Combustable | Wind Dispersable | Consequence | Scenario |
|---|---|---|---|---|---|---|---|---|---|
| 1 | + | + | + | + | + | | + | These Sequences describe containers with mixed content of solids and liquids and gases. They are better represented by scenarios which address each type of content separately. | Included in B–3, B–4, B–5, B–6 |
| 2 | + | + | + | + | + | | – | | |
| 3 | + | + | + | + | – | | + | | |
| 4 | + | + | + | + | – | | – | | |
| 5 | + | + | + | – | + | | + | | |
| 6 | + | + | + | – | + | | – | | |
| 7 | + | + | + | – | – | | + | | |
| 8 | + | + | + | – | – | | – | | |
| 9 | + | + | – | + | + | | + | Illogical | |
| 10 | + | + | – | + | + | | – | Illogical | |
| 11 | + | + | – | + | – | | + | Illogical | |
| 12 | + | + | – | + | – | | – | Illogical | |
| 13 | + | + | – | – | + | | + | Represented more significantly in flood scenarios | |
| 14 | + | + | – | – | + | | – | Represented more significantly in flood scenarios | |
| 15 | + | + | – | – | – | | + | Site or overpack contaminated w/solid | |
| 16 | + | + | – | – | – | | – | Site or overpack contaminated w/solid | B–6 |
| 17 | + | – | + | + | + | | + | Illogical | |
| 18 | + | – | + | + | + | | – | Illogical | |
| 19 | + | – | + | + | – | | + | Illogical | |
| 20 | + | – | + | + | – | | – | Illogical | |
| 21 | + | – | + | – | + | | + | Illogical | |
| 22 | + | – | + | – | + | | – | Site or overpack contamination w/liquid | B–3, B–4 |
| 23 | + | – | + | – | – | | + | Illogical | |
| 24 | + | – | + | – | – | | – | Site or overpack contamination w/liquid | B–3, B–4 |
| 25 | + | – | – | + | + | | + | | |
| 26 | + | – | – | + | + | | – | | |
| 27 | + | – | – | + | – | | + | Vapor release to atmosphic | B–5 |
| 28 | + | – | – | + | – | | – | | |
| 29 | + | – | – | – | + | | + | | |
| 30 | + | – | – | – | + | | – | | |
| 31 | + | – | – | – | + | | + | Illogical | |
| 32 | + | – | – | – | – | | – | | |

Omitted – not pertinent to this initiating event

Figure C.2-1. Complete Event Matrix for Container Rupture Initiating Events or Spill.

Activity Phase – On Site Handling and Emplacement
Packages – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–5

INITIATING EVENT – CONTAINER RUPTURE OR WASTE SPILL

| | Container Rupture | Solid | Liquid | Volatile Vapors | Soluble | Combustible | Wind Dispersable | Consequence | Scenarios |
|---|---|---|---|---|---|---|---|---|---|
| 1 | + | + | – | – | – | – | + | Site or overpack contamination w/solid | B–6 |
| 2 | + | + | – | – | + | – | – | Represented more significantly in flood scenarios | |
| 3 | + | – | + | – | + | – | – | Site or overpack contamination w/liquid | |
| 4 | + | – | + | – | – | – | – | Site or overpack contamination w/liquid | B–3, B–4 |
| 5 | + | – | – | + | – | – | – | Atmospheric release | B–5 |
| 6 | + | + | + | + | + | – | + | Site or overpack contamination w/solid or w/liquid and atmospheric release | B–3, B–4, B–5, B–6 |

Figure C.2-2. Reduced Event Matrix for Container Rupture or Spill.

Activity Phase – On Site Handling and Emplacement
Packages – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–5

INITIATING EVENT – WASTE FIRE

| | Waste Fire | Solid | Liquid | Volatile Vapors | Soluble | Combustible | Wind Dispersable | Consequence | Scenarios |
|---|---|---|---|---|---|---|---|---|---|
| 1 | + | + | – | – | – | + | – | Atmospheric release | B–7 |
| 2 | + | + | – | – | – | – | – | No consequence | |
| 3 | + | + | – | – | + | + | – | Atmospheric release, site contamination | B–8 |
| 4 | + | – | + | – | – | + | – | Atmospheric release, site contamination | B–8 |
| 5 | + | – | + | – | – | – | – | No consequence | |
| 6 | + | – | – | + | – | + | – | Atmospheric release | B–7 |
| 7 | + | – | – | + | – | – | – | Atmospheric release | B–7 |
| 8 | + | + | + | + | + | + | – | Atmospheric release, site contamination | B–7, B–8 |

Figure C.2-3. Reduced Event Matrix for Fire.

Activity Phase – On Site Handling and Emplacement
Packages – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–5

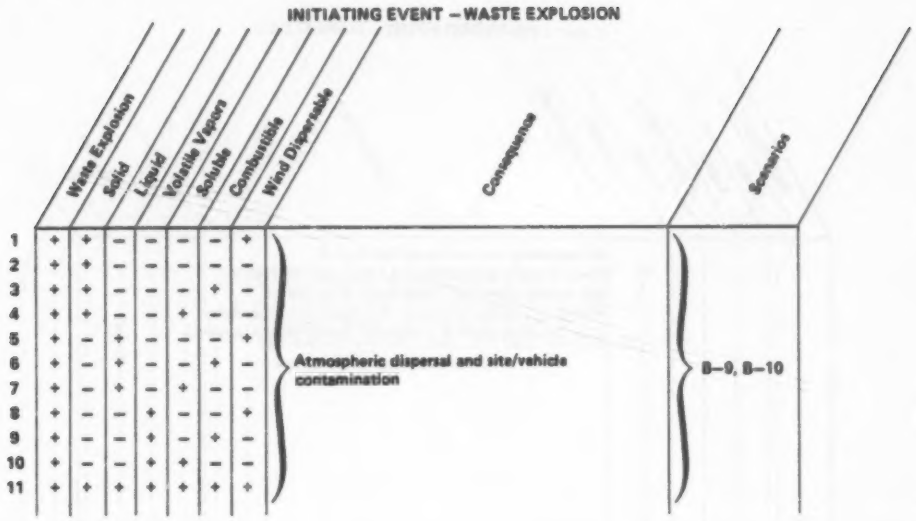
INITIATING EVENT – WASTE EXPLOSION
Waste Explosion
Solid
Liquid
Volatile Vapors
Soluble
Combustible
Wind Dispersable
Consequence
Scenarios
1 + + – – – – +
2 + + – – – – –
3 + + – – – + –
4 + + – – + – –
5 + – + – – – +
6 + – + – – + –
7 + – + – + – –
8 + – – + – – +
9 + – – + – + –
10 + – – + + – –
11 + + + + + + +
Atmospheric dispersal and site/vehicle contamination
B–9, B–10

Figure C.2-4. Reduced Matrix for Waste Explosion.

Activity Phase – On Site Handling and Emplacement
Package – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–5

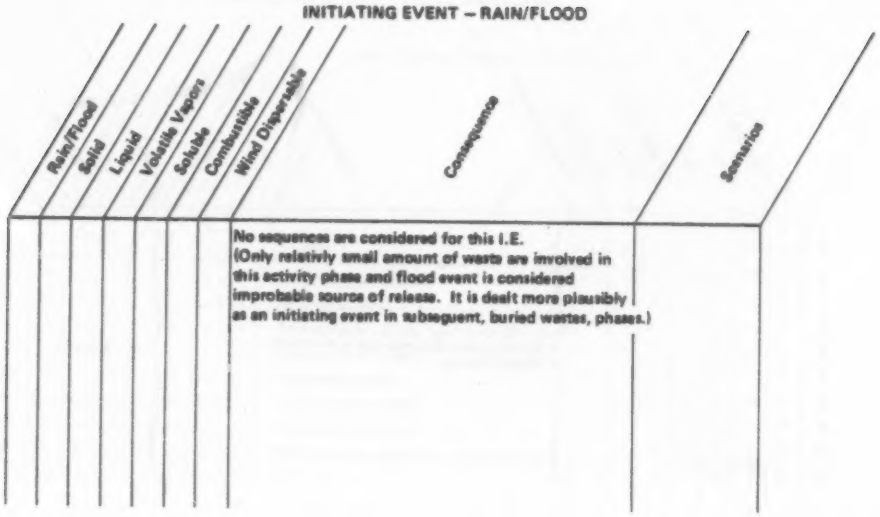
INITIATING EVENT – RAIN/FLOOD
Rain/Flood
Solid
Liquid
Volatile Vapors
Soluble
Combustible
Wind Dispersable
Consequence
Scenarios
No sequences are considered for this I.E.
(Only relativly small amount of waste are involved in this activity phase and flood event is considered improbable source of release. It is dealt more plausibly as an initiating event in subsequent, buried wastes, phases.)

Figure C.2-5. Rain/Flood.

Activity Phase – On Site Handling and Emplacement
Package – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–5

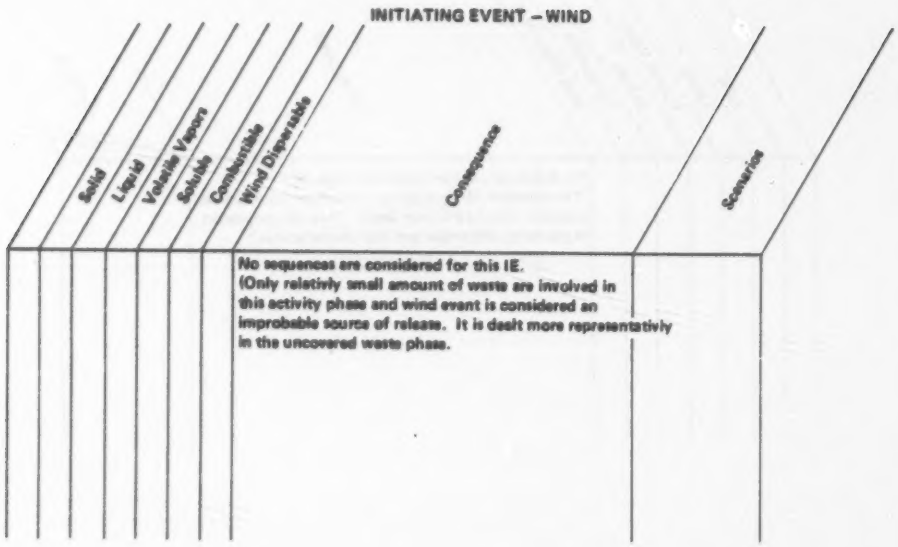
INITIATING EVENT – WIND
Solid
Liquid
Volatile Vapors
Soluble
Combustible
Wind Dispersable
Consequence
Scenarios
No sequences are considered for this IE.
(Only relativly small amount of waste are involved in this activity phase and wind event is considered an improbable source of release. It is dealt more representativly in the uncovered waste phase.

Figure C.2-6. Wind.

Activity Phase – On Site Handling and Emplacement
Packages – Drums, Cartons, Boxes
Waste Type – WS–2, WS–3, WS–4, WS–6

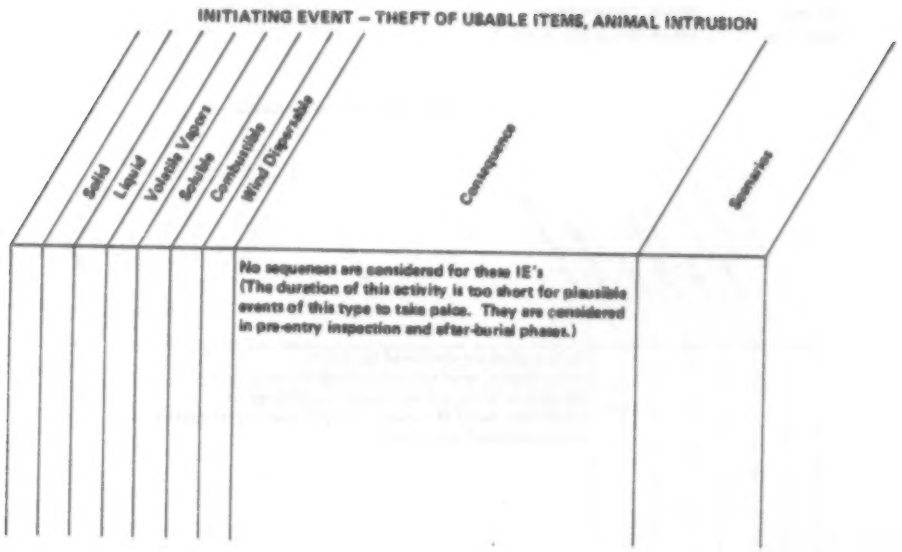
INITIATING EVENT – THEFT OF USABLE ITEMS, ANIMAL INTRUSION
Solid
Liquid
Volatile Vapors
Soluble
Combustible
Wind Dispersable
Consequence
Scenarios
No sequences are considered for these IE's
(The duration of this activity is too short for plausible events of this type to take place. They are considered in pre-entry inspection and after-burial phases.)

Figure C.2-7. Theft/Intrusion.

# APPENDIX D

# PROGRAM LISTING

```
      1       PROGRAM BURYIT
              C
              C     IN EACH ROUTINE COMMON BLOCKS THAT CONTAIN
              C     VARIABLES USED IN THAT ROUTINE ARE SO DEFINED IN THE PROLOGUE.
              C     AN * IN FRONT OF THE VARIABLE IMPLIES THAT THE VARIABLE IS
              C     DEFINED OR RESET IN THIS ROUTINE.  THOSE THAT ARE DEFINED FOR
              C     THE FIRST TIME ARE DEFINED UNDER VARIABLE-DESCRIPTIONS.
              C
              C     NECESSARY FILES AND THEIR UNIT NUMBER
              C      INPUT.DAT - 14
              C      SCENE.DAT - 7
              C      INVENT.DAT - 12
              C      TITLE.DAT - 13
              C      AQUA.DAT - 11
              C      GEOLGY.DAT - 10
              C      EROSIO.DAT - 8
              C      ATMOS.FIL - 9
              C      DIRECT.DAT - 20
              C      DOSE.DAT - 15
              C      NUCNAM.FIL - 2
              C      NUCDAT.FIL - 1
              C
              C*ABSTRACT: Shallow Land Burial Program.
              C
              C*PURPOSE:  Program for evaluating the dose received from a burial site
              C           or burialrelated over a period of time due to an accident,
              C           human error, or natural causes.
              C
              C*AUTHOR:  D. BUCKLEY
              C          W. HORTON
              C          T. KUHN
              C          D. LESTER
              C          T. PASTERNAK
              C          L. ROBERTSON
              C          M. SPAETH
              C          J. STODDARD
              C
              C*TYPE:    Main
              C
              C*CALLS TO:
              C          SUMDOS, PREDOS, EXEC, OUTPUT
              C
              C*COMMON BLOCKS:
              CNAME      ALL
              C           *ipathz, *nd, *vol, *dl
              CNAME      HYDRA
              C           *numnuc, *oricnt, *cumt
              CNAME      VAR
              C           *lcall
              CNAME      XDATA
              C           *name, *ititle, *iprnt
              CNAME      MDATA
              C           *clmt, *dose, *voln
              CNAME      LDATA
              C           *tdose, *tdosep, *tdosel, *tdosej, *tdosek, *tdosem,
              C           *tdosel
              C
              C*TECHNICAL DESCRIPTION:
```

```
C       This program is used for evaluating the dose received
C       by a person or a group of people due to an exposure with
C       nuclear wastes.  It was designed using existing methodologies
C       as presented in task-2 report (SAI01380-4781j).
C     Variable Descriptions:
C       INTER - Variable used to define which mode of communication
C               is to be used.
C                0 = interactive
C                1 = batch job
C       IPRNT - Variable used to adjust the amount of output received.
C                0 = summary output
C                1 = summary output + calling routines when INTER = 1
C                2 = summary output + detailed output from UNSAT
C                    CAUTION : THIS COULD BE AN ENORMOUS AMOUNT OF OUTPUT..
C       ITITLE - 60 character label which will be reproduced in the output
C       DOSE - Direct exposure dose (person-REM)
C       TDOSEP - Total cumulative population dose over all paths for the
C                scenario.
C       TDOSE - Total direct dose over all paths for the scenario.
C       TDOSEI - Dose breakdown by isotope.
C       TDOSEJ - Dose breakdown by distance from the source.
C       TDOSEL - Dose breakdown by organ.
C       TDOSEK - Dose breakdown by pathway.
C       TDOSEM - Dose breakdown by age group.
C       ISCEN - Scenario number as listed in the users manual.
C       IPATH - Different dose paths available for the scenario assigned.
C       IS - Scenario number to be checked against 'ISCEN' from file 'SCENE
C       IBLURB - Scenario description that goes with 'IS'.
C       INVET - Inventory that goes with 'IS'.
C       IPATHS - Different paths available for the scenario assigned 'IS'.
C       SFR - Release fraction for scenario 'IS'.
C       IH - Number of words in the title on the file 'TITLE'.
C       IHT - Title of scenario.
C       NUMNUC - Number of nuclides.
C       FR - The total amount of curies/cubic meter for inventories
C            ws-1 to ws-5.
C       NAME - Nuclide name
C       ORI - The nuclide percentage of the total inventory for
C             inventories ws-1 to ws-5.  The actual amount of inventory
C             for ws-6.
C       CUMT - Exposure time in hours except in unsat which is in years.
C       CIMT - Exposure time in hours for subroutine DIRECT.
C       VOL - Volume of package involved in scenario. (cubic meters)
C       UD - Velocity of wind at accident site in meters/sec.  Used
C            in subroutine doset.
C       DI - Diameter of dust cloud in meters.  Used in doset.
C
      2       LOGICAL MAXIND
      3       COMMON/ALL/ IPATHZ(4),UD,VOL,DI,INTER,NT
      4       COMMON/HYDRA/ JK,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,
     1 DD(60),P(52),E(52),W(60),TIMINC,CONQ,DDRY,HWET,WATL,WATH,
     2 CONCOF(60),DNSTY(60),XD(45,60),SOLFAC(45),
     3 ORICNT(45),CUMT,IPASS
      5       COMMON/VAR/PAC84,KLSP,RDCHT,RDCSP,RDCRCH,ANC,WNDFRC,
     1 HTBR,FW,R,A,CK5,CK6,CK8,CK9,CK11,
     2 CK13,CK1,CK2,CK3,CK4,ANS,SAIR,NU,FL,ANGL,MAT,ANGWND,ICALL
      6       COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      7       COMMON/HDATA/IST,RANGE,NSH,MATRL(5),THK(5),CIMT,DOSE,VOLA
```

```
      8            COMMON/LDATA/ TDOSE,TDOSEP,TDOSEI(45),TDOSEJ(20),TDOSEK(9),
                  1 TDOSEM(3),TDOSEL(9)
      9            COMMON/FDATA/CI(45),VD(45),WC(45),MAXIND
     10            DIMENSION IPATHS(3,4),SFR(4),INVS(6),ORI(45),IHT(48),IHS(7,9)
     11            DATA INVS/4HWS-1,4HWS-2,4HWS-3,4HWS-4,4HWS-5,4HWS-6/
     12            DATA IHS/5HAQUIF,5HER TR,5HANSPO,2HRT,1H ,1H ,1H ,
                  1 5HATMOS,5HPHERI,5HC TRA,5HNSPOR,1HT,1H ,1H ,
                  2 5HWASTE,5H CONT,5HACT (,5HSHINE,1H),1H ,1H ,
                  3 5HDOSE ,5HCALCU,5HLATIO,1HN,1H ,1H ,1H ,
                  4 5HWIND ,5HEROSI,2HON,1H ,1H ,1H ,1H ,
                  5 5HINPUT,5H PREP,5HARATI,2HON,1H ,1H ,1H ,
                  6 5HOUTPU,5HT PRI,2HNT,1H ,1H ,1H ,1H ,
                  7 5HNUCLI,5HDE DA,5HTA BA,5HSE AC,4HCESS,1H ,1H ,
                  8 5HUNSAT,5HURATE,5HD ZON,5HE WAT,5HER TR,5HANSPO,2HRT/
     13            OPEN(UNIT=6,DEVICE='DSK',FILE='BURY.IT')
     14            NT=5
     15            NO=6
     16            NS=7
     17            NTI=13
     18            NIN=12
     19            OPEN(UNIT=14,DEVICE='DSK',FILE='INPUT.DAT')
           C  INTER = 1  IMPLIES A BATCH JOB
     20            READ(14,20) INTER,IPRNT,(ITITLE(I),I=1,12)
     21       20   FORMAT(211,12A5)
     22            READ(14,22) MAXI
     23       22   FORMAT(I1)
     24            MAXIND=.FALSE.
     25            IF(MAXI.EQ.1) MAXIND=.TRUE.
     26       10   CALL SUMDOS(0,0,0,0,0,0.)
     27            TDOSEP=0.
     28            TDOSE=0.
     29            DOSE=0.
     30            DO 15 I=1,45
     31            TDOSEI(I)=0.
     32       15   CONTINUE
     33            DO 16 I=1,20
     34            TDOSEJ(I)=0.
     35       16   CONTINUE
     36            DO 17 I=1,9
     37            TDOSEL(I)=0.
     38            TDOSEK(I)=0.
     39       17   CONTINUE
     40            DO 18 I=1,3
     41            TDOSEM(I)=0.
     42       18   CONTINUE
     43            IF(INTER.EQ.1) GO TO 30
     44            WRITE(NT,100)
     45      100   FORMAT(2X,31HWHAT SCENARIO ARE YOU RUNNING ? )
     46            READ(NT,*) ISCEN
           C   FIND OUT WHICH SCENARIO WAS CHOSEN
     47            GO TO 35
     48       30   READ(14,21,END=351) ISCEN
     49       21   FORMAT(I3)
     50       35   OPEN(UNIT=7,DEVICE='DSK',FILE='SCENE.DAT')
     51            DO 110 I=1,ISCEN
     52            READ(NS,111) IPATH,IS,IBLURB,INVET,((IPATHS(J,K),K=1,4),
                  1 SFR(J),J=1,IPATH)
     53      111   FORMAT(I1,I3,A4,A4,3(1X,4I1,E8.1))
```



READER'S FICHE

```
      110  CONTINUE
           CLOSE(UNIT=7,DEVICE='DSK')
           IF(IS.NE.ISCEN) STOP 01
C    FIND THE PROPER BLURB THAT GOES WITH THIS SCENARIO
           OPEN(UNIT=13,DEVICE='DSK',FILE='TITLE.DAT')
           DO 112 J=1,59
           READ(NTI,113) IX,IH,(IHT(I),I=1,IH)
      113  FORMAT(A4,1X,I2,1X,48(A5))
           IF(IX.EQ.IBLURB) GO TO 114
      112  CONTINUE
           STOP 02
      114  CONTINUE
           CLOSE(UNIT=13,DEVICE='DSK')
           WRITE(NO,119) (ITITLE(I),I=1,12),IS
      119  FORMAT(1H1,//,45X,12A5,//,45X,17HSCENARIO NUMBER :,I3)
           WRITE(NO,120) (IHT(I),I=1,IH)
      120  FORMAT(//,5(45X,10A5,/))
           WRITE(NO,121) INVET
      121  FORMAT(//51X,11HINVENTORY :,
     1 A4,//42X,4HPATH,6X,4HPATH,10X,7HRELEASE,/41X,6HNUMBER,19X,
     2 8HFRACTION)
           DO 122 J=1,IPATH
           WRITE(NO,123) J,(IPATHS(J,K),K=1,4),SFR(J)
      123  FORMAT(40X,I4,8X,4I1,10X,E8.1)
           DO 124 K=1,4
           II=IPATHS(J,K)
           IF(II.LT.1) GO TO 122
           WRITE(NO,125) II,(IHS(L,II),L=1,7)
      125  FORMAT(52X,I1,2X,7A5,/)
      124  CONTINUE
      122  CONTINUE
           DO 130 I=1,6
           IF(INVET.EQ.INVS(I)) GO TO 132
      130  CONTINUE
                STOP 03
      132  II=I
           IF(I.GE.5) II=5
           OPEN(UNIT=12,DEVICE='DSK',FILE='INVENT.DAT')
           DO 140 L=1,II
           READ(NIN,133) IX,NUMNUC
      133  FORMAT(A4,I4)
           READ(NIN,134) FR
      134  FORMAT(E8.2)
           DO 135 J=1,NUMNUC
           READ(NIN,136) (NAME(J,K),K=1,2),ORI(J)
      136  FORMAT(A3,A2,E9.2)
      135  CONTINUE
      140  CONTINUE
           IF(II.EQ.1) GO TO 150
           READ(NIN,133) IX,NUMNUC
           DO 137 J=1,NUMNUC
           READ(NIN,136) (NAME(J,K),K=1,2),ORI(J)
      137  CONTINUE
           CLOSE(UNIT=12,DEVICE='DSK')
           IF(I.GT.5) GO TO 156
      150  CONTINUE
           DO 155 J=1,NUMNUC
           ORI(J)=ORI(J)*FR
```

```
      155  CONTINUE
C   NOW TO LOOP ON NUMBER OF PATHS
      156  ITI=0
           IVOL=0
           IVEL=0
           ICALL=0
           DO 200 L=1,IPATH
           DOSE=0.0
           CALL SUMDOS(0.,0.,0.,0.,0.,0.)
           WRITE(NO,205) L
      205  FORMAT(1H1,//,50X,12HPATH NUMBER:,I3)
           DO 207 K=1,4
           II=IPATHS(L,K)
           IF(II.LT.1) GO TO 207
           WRITE(NO,125) II,(IHS(LL,II),LL=1,7)
      207  CONTINUE
           WRITE(NO,208)
      208  FORMAT(/,45X,7HNUCLIDE,5X,6HAMOUNT,/,56X,7HCI/M**3 ,/)
           DO 210 I=1,NUMNUC
           ORICNT(I)=ORI(I)*SFR(L)
           WRITE(NO,211) (NAME(I,K),K=1,2),ORICNT(I)
      211  FORMAT(46X,2A3,3X,1PE9.3)
      210  CONTINUE
           IF(SFR(L).EQ.0.0) GO TO 200
           CALL PREDOS
           DO 215 I=1,4
           IPATHZ(I)=IPATHS(L,I)
           IPZ=IPATHZ(I)
           IF(IPATHS(L,I).LT.1) GO TO 215
           IF(IPZ.NE.9.AND.ITI.EQ.1) GO TO 248
           ITI=1
           IF(INTER.EQ.1) GO TO 246
           IF(IPZ.NE.9) GO TO 219
           WRITE(NT,218)
      218  FORMAT(2X,46HFOR UNSAT; HOW MANY YEARS DO YOU WANT TO RUN ? )
           GO TO 244
      219  WRITE(NT,217)
      217  FORMAT(2X,33HWHAT IS THE EXPOSURE TIME ? (HRS) )
      244  READ(NT,*) CUMT
           GO TO 248
      246  READ(14,247) CUMT
      247  FORMAT(E12.4)
      248  IF(IPZ.EQ.9) CUMT=CUMT*24.*365.
           IF(IPZ.EQ.9) WRITE(NO,260) CUMT
      260  FORMAT(/,5X,35HWILL RUN PROBLEM THROUGH UNSAT FOR ,E12.4,
          1 2X,5HHOURS)
           IF(IPZ.NE.9) WRITE(NO,261) CUMT
      261  FORMAT(/,25X,17HEXPOSURE TIME IS ,E12.4,5HHOURS)
           CIMT=CUMT
           IF(IPZ.NE.1) GO TO 220
           GO TO 250
      220  IF(IPZ.GT.3) GO TO 235
           IF(IVOL.EQ.1) GO TO 250
           IVOL=1
           IF(INTER.EQ.1) GO TO 222
           WRITE(NT,221)
      221  FORMAT(2X,68HWHAT IS THE VOLUME OF THE BOX OR PACKAGE INVOLVED IN
          1THIS SCENARIO ? ,/,2X,17H(IN CUBIC METERS) )
```

```
      READ(NT,*) VOL
      WRITE(NO,262) VOL
262   FORMAT(/,25X,21HVOLUME OF PACKAGE IS ,E12.4,13H CUBIC METERS)
      GO TO 250
222   READ(14,247) VOL
      WRITE(NO,262) VOL
      GO TO 250
235   IF(IPZ.NE.4) GO TO 240
      IF(IVEL.EQ.1) GO TO 250
      IVEL=1
      IF(INTER.EQ.1) GO TO 233
      WRITE(NT,231)
231   FORMAT(2X,58HWHAT IS THE VELOCITY OF THE WIND AT THE ACCIDENT ? (M
     1/SEC) )
      READ(NT,*) UD
C   2.2352 METERS/SEC = 5 MILES/HOUR
      UD=AMAX1(UD,2.2352)
      WRITE(NT,232)
232   FORMAT(2X,76HWHAT IS THE DIAMETER IN METERS OF THE DUST CLOUD RELE
     1ASED IN THIS SCENARIO ? )
      READ(NT,*) DI
      GO TO 250
233   READ(14,234) UD,DI
234   FORMAT(2E12.4)
      GO TO 250
240   IF(IPZ.NE.5) GO TO 245
      GO TO 250
245   IF(IPZ.NE.9) STOP 04
250   CONTINUE
      VOLA=VOL
      CALL EXEC(IPZ)
215   CONTINUE
      IL=L
      CALL OUTPUT(IL)
200   CONTINUE
      CALL OUTPUT(0)
      IF(INTER.EQ.1) GO TO 10
      WRITE(NT,298) ISCEN
298   FORMAT(/2X,10HSCENARIO :,1X,I3,2X,9HCOMPLETED,/)
      WRITE(NT,300)
300   FORMAT(2X,37HDO YOU WISH TO RUN ANOTHER SCENARIO ? )
      READ(NT,301) IH
301   FORMAT(A3)
      IF(IH.EQ.3HYES) GO TO 10
      WRITE(NT,350)
350   FORMAT(//,5X,27HGOOD BYE  FROM SHALLOW LAND )
351   STOP
      END
```

LIST OF CODES INDICATING VARIABLE USE OR TYPE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AC -- ACCEPT | DA -- DATA | EQ -- EQUIVALENCE | OP -- OPEN | RR -- REREAD | | | |
| AC -- SUBROUTINE ARGUMENT | DB -- DOUBLE PRECISION | F -- FORTRAN KEYWORD | PM -- PARAMETER | SU -- SUBROUTINE | | | |
| AS -- ASSIGN | DC -- DECODE | FN -- FUNCTION NAME | PR -- PRINT | TY -- TYPE | | | |
| CL -- CLOSE | DI -- DIMENSION | IN -- INTEGER | PU -- PUNCH | WR -- WRITE | | | |
| CN -- COMMON NAME | DO -- DO | LG -- LOGICAL | RD -- READ | = -- ASSIGNMENT | | | |
| CO -- COMMON | EC -- ENCODE | NM -- NAMELIST | RL -- REAL | * -- STATEMENT # DEFINED | | | |
| CX -- COMPLEX | | | | | | | |

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 5C0 | CK13 | -R | 5C0 | DELW | -R | 4C0 | HWET | -R | 4C0 | MDATA | - | 7CN | RDCHT | -R | 5C0 | W | ()R | 4C0 |
| ALL | - | 3CN | CK2 | -R | 5C0 | DIMENS | - | 10F | HYDRA | - | 4CN | N | -I | 6C0 | RDCRCH | -R | 5C0 | WATH | -R | 4C0 |
| AMAXI | - | 170SU | CK3 | -R | 5C0 | DNSTY | ()R | 4C0 | IR | -I | 4C0 | ND | -I | 4C0 | RDCSP | -R | 5C0 | WATL | -R | 4C0 |
| ANG | -R | 5C0 | CK4 | -R | 5C0 | DRY | -R | 4C0 | IPASS | -I | 4C0 | NSH | -I | 7C0 | SAIR | -R | 5C0 | WC | ()R | 9C0 |
| ANGL | -R | 5C0 | CK5 | -R | 5C0 | E | ()R | 4C0 | IST | -I | 7C0 | NU | -I | 5C0 | SOLFAC | ()R | 4C0 | WHDFRC | -R | 5C0 |
| ANGWND | -R | 5C0 | CK6 | -R | 5C0 | EXEC | - | 191SU | JK | -I | 4C0 | P | ()R | 4C0 | THK | ()R | 7C0 | XD | ()R | 4C0 |
| ANS | -R | 5C0 | CK8 | -R | 5C0 | FDATA | - | 9CN | KLSP | -I | 5C0 | PAC84 | -R | 5C0 | TIMDRY | -R | 4C0 | XDATA | - | 6CN |
| BURVIT | - | 1SU | CK9 | -R | 5C0 | FL | -R | 5C0 | LDATA | - | 8CN | PREDOS | - | 132SU | TIMINC | -R | 4C0 | | | |
| CI | ()R | 9C0 | CONCOF | ()R | 4C0 | FW | -R | 5C0 | LOGICA | - | 2F | R | -R | 5C0 | TIMWET | -R | 4C0 | | | |
| CK1 | -R | 5C0 | CONQ | -R | 4C0 | HDRY | -R | 4C0 | MAT | -I | 5C0 | RAIN | -R | 4C0 | VAR | - | 5CN | | | |
| CK11 | -R | 5C0 | DD | ()R | 4C0 | HTBR | -R | 5C0 | MATRL | ()I | 7C0 | RANGE | -R | 7C0 | VD | ()R | 9C0 | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CALL | - | 26F | 116F | 132F | 191F | 194F | 196F | | | | | | | | | | | | |
| CINT | -R | 7C0 | 155= | | | | | | | | | | | | | | | | |
| CLOSE | - | 55F | 65F | 104F | | | | | | | | | | | | | | | |
| COMMON | - | 3F | 4F | 5F | 6F | 7F | 8F | 9F | | | | | | | | | | | |
| CONT | -R | 4C0 | 146RD | 148RD | 150= | 150 | 151WR | 153WR | 155 | | | | | | | | | | |
| DATA | - | 11F | 12F | | | | | | | | | | | | | | | | |
| DI | -R | 3C0 | 181RD | 183RD | | | | | | | | | | | | | | | |
| DOSE | -R | 7C0 | 29= | 115= | | | | | | | | | | | | | | | |
| FR | -R | 92RD | 108 | | | | | | | | | | | | | | | | |
| I | -I | 20RD | 20RD | 30DO | 31 | 33DO | 34 | 36DO | 37 | 38 | 40DO | 41 | 51DO | 59RD | 59RD | 66WR | 66WR | 68WR | |
| | | 68WR | 82DO | 83 | 86 | 87 | 99 | 105 | 126DO | 127 | 127 | 128WR | 128WR | 133DO | 134 | 134 | 135 | 156 | |
| IBLURR | -I | 52RD | 61 | | | | | | | | | | | | | | | | |
| ICALL | -I | 5C0 | 143= | | | | | | | | | | | | | | | | |
| IF | - | 25F | 43F | 56F | 61F | 77F | 83F | 87F | 99F | 105F | 121F | 131F | 136F | 137F | 139F | 140F | 150F | 151F | |
| | | 153F | 156F | 158F | 159F | 161F | 171F | 172F | 174F | 186F | 188F | 197F | 204F | | | | | | |
| IH | -I | 59RD | 59RD | 68WR | 202RD | 204 | | | | | | | | | | | | | |
| IHS | ()I | 10D1 | 12DA | 78WR | 122WR | | | | | | | | | | | | | | |
| IHT | ()I | 10D1 | 59RD | 68WR | | | | | | | | | | | | | | | |
| II | -I | 76= | 77 | 78WR | 78WR | 86= | 87= | 89DO | 99 | 120= | 121 | 122WR | 122WR | | | | | | |
| IL | -I | 193= | 194AC | | | | | | | | | | | | | | | | |
| INTER | -I | 3C0 | 20RD | 43 | 139 | 161 | 174 | 197 | | | | | | | | | | | |
| IRVET | -I | 52RD | 70WR | 83 | | | | | | | | | | | | | | | |
| IRVS | ()I | 10D1 | 11DA | 83 | | | | | | | | | | | | | | | |
| IPATH | -I | 52RD | 52RD | 72DO | 114DO | | | | | | | | | | | | | | |
| IPATHS | ()I | 10D1 | 52RD | 73WR | 76 | 120 | 134 | 136 | | | | | | | | | | | |
| IPATHZ | ()I | 3C0 | 134= | 135 | | | | | | | | | | | | | | | |
| IPRNT | -I | 6C0 | 20RD | | | | | | | | | | | | | | | | |
| IPZ | -I | 135= | 137 | 140 | 150 | 151 | 153 | 156 | 158 | 171 | 186 | 188 | 191AC | | | | | | |
| IS | -I | 52RD | 56 | 66WR | | | | | | | | | | | | | | | |
| ISCEN | -I | 46RD | 48RD | 51DO | 56 | 190WR | | | | | | | | | | | | | |
| ITI | -I | 110= | 137 | 138= | | | | | | | | | | | | | | | |
| ITITLE | ()I | 6C0 | 20RD | 66WR | | | | | | | | | | | | | | | |
| IVEL | -I | 112= | 172 | 173= | | | | | | | | | | | | | | | |
| IVOL | -I | 111= | 159 | 160= | | | | | | | | | | | | | | | |

IX -I 59RD 61 90RD 100RD
J -I 52RD 52RD 52RD 58DO 72DO 73WR 73WR 73WR 76 94DO 95RD 95RD 101DO 102RD 102RD 107DO 108
108
K -I 52RD 52RD 73WR 73WR 75DO 76 95RD 95RD 102RD 102RD 119DO 120 128WR 128WR
L -I 70WR 70WR 89DO 114DO 117WR 120 127 131 134 136 193
LL -I 122WR 122WR
MAXI -I 22RD 25
MAXIND -L 21C 9CO 24= 25=
NAME ()I 6CO 95RD 102RD 128WR
NIN -I 18= 90RD 92RD 95RD 100RD 102RD
NO -I 15= 66WR 68WR 70WR 73WR 70WR 117WR 122WR 124WR 128WR 151WR 153WR 165WR 169WR
NS -I 16= 52RD
NT -I 3CO 14= 44WR 46RD 141WR 144WR 146RD 162WR 164RD 175WR 177RD 179WR 181RD 198WR 200WR 202RD 205WR
NTI -I 17= 59RD
NUMNUC -I 4CO 90RD 94DO 100RD 101DO 107DO 126DO
OPEN - 13F 19F 50F 57F 88F
ORI ()R 10D1 95RD 102RD 108= 108 127
ORICNT ()R 4CO 127= 128WR
OUTPUT - 194SU 196SU
READ - 20F 22F 46F 48F 52F 59F 90F 92F 95F 100F 102F 146F 148F 164F 168F 177F 181F
183F 202F
SFR ()R 10D1 52RD 73WR 127 131
STOP - 56F 63F 85F 180F 207F
SUBDOS - 26SU 116SU
TDOSE -R BCO 28=
TDOSEI ()R BCO 31=
TDOSEJ ()R BCO 34=
TDOSEK ()R BCO 38=
TDOSEL ()R BCO 37=
TDOSEM ()R BCO 41=
TDOSEP -R BCO 27=
UD -R 3CO 177RD 178= 178 183RD
VOL -R 3CO 164RD 165WR 168RD 169WR 190
VOLA -R 7CO 190=
WRITE - 44F 66F 68F 70F 73F 78F 117F 122F 124F 128F 141F 144F 151F 153F 162F 165F 169F
175F 179F 198F 200F 205F
10 - 26* 197 204
15 - 30DO 32*
16 - 33DO 35*
17 - 36DO 39*
18 - 40DO 42*
20 - 20RD 21*
21 - 48RD 49*
22 - 22RD 23*
30 - 43 48*
35 - 47 50*
100 - 44WR 45*
110 - 51DO 54*
111 - 52RD 53*
112 - 58DO 62*
113 - 59RD 60*
114 - 61 64*
119 - 66WR 67*
120 - 68WR 69*
121 - 70WR 71*
122 - 72DO 77 81*
123 - 73WR 74*
124 - 75DO 80*

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 123  -    78WR   79*   122WR
 130  -    82DO   84*
 132  -    83     86*
 133  -    90RD   91*   100RD
 134  -    92RD   93*
 135  -    94DO   97*
 136  -    95RD   96*   102RD
 137  -   101DO  103*
 140  -    89DO   98*
 150  -    99     106*
 155  -   107DO  109*
 156  -   105    110*
 200  -   114DO  131    195*
 205  -   117WR  118*
 207  -   119DO  121    123*
 208  -   124WR  125*
 210  -   126DO  130*
 211  -   128WR  129*
 215  -   133DO  136    192*
 217  -   144WR  145*
 218  -   141WR  142*
 219  -   140    144*
 220  -   156    158*
 221  -   162WR  163*
 222  -   161    168*
 231  -   175WR  176*
 232  -   179WR  180*
 233  -   174    183*
 234  -   183RD  184*
 235  -   150    171*
 240  -   171    186*
 244  -   143    146*
 245  -   186    188*
 246  -   139    148*
 247  -   148RD  149*   160RD
 248  -   137    147    150*
 250  -   157    159    167    170    172    182    185    187    189*
 260  -   151WR  152*
 261  -   153WR  154*
 262  -   165WR  166*   169WR
 298  -   198WR  199*
 300  -   200WR  201*
 301  -   202RD  203*
 350  -   205WR  206*
 351  -    40RD  207*
```

```
      1          SUBROUTINE EXEC(IPZ)
                 C
                 C*ABSTRACT:  The director  for the  Shallow Land
                 C            Burial Program.
                 C
                 C*AUTHOR: L. ROBERTSON  NOVEMBER 17 , 1980.
                 C
                 C*TYPE: IO
                 C
                 C*PARAMETER DESCRIPTION:
                 CIN       IPZ - Path number
                 C             1 = aquifer transport
                 C             2 = atmospheric transport
                 C             3 = waste contact
                 C             4 = dose calculation
                 C             5 = wind erosion
                 C             6 = unsaturated zone water transport
                 C
                 C*CALLED BY:
                 C         BURYIT
                 C
                 C*CALLS TO:
                 C         UNSAT, CNT, AQUIFR, DOSET, EROSIO, ATMOS, DIRECT
                 C
                 C*COMMON BLOCKS:
                 CNAME       DOSEB
                 C            *ip
                 CNAME       TSTEP
                 C            t, *d, ddd
                 CNAME       AQUA
                 C            *el, *vz, *ti, *tz, rnwv
                 CNAME       ATM02
                 C            gc, *act
                 CNAME       DAQUA
                 C            dosex, tis, its, *dosee, tin, itl
                 CNAME       EROS
                 C            *nuc, *tim, *dens, *xnucin, *xncout
                 CNAME       HYDRA
                 C            numnuc, dd, dusty, orient, cumt, *ipass
                 CNAME       XDATA
                 C            name, iprnt
                 CNAME       FFFFC
                 C            *ac
                 CNAME       VAR
                 C            fw, fl
                 CNAME       FDATA
                 C            *cl, *wc
                 C
                 C*TECHNICAL DESCRIPTION:
                 C             Calls all routines as directed by the input and manipulates
                 C             the data as necessary.
                 C           VARIABLE DESCRIPTIONS:
                 C             IP - Population distribution for each segment
                 C             D - Dose out of AQUIFR for each nuclide for each
                 C                 time bin as set set up by subroutine CNT.
                 C             EI - Axial dispersion coefficient. (cm**2/min.)
                 C             VZ - Dispersing of nuclides. (feet/day)
                 C             TI - Leach duration (years)
```

```
C     TZ - Time of leach incident (years)
C     ACT - Time integrated air concentration (ci/meters**3)
C     DOSEE - Total dose out of unsat into AQUIFR for each time
C          block and nuclide.
C      NUC - Number of nuclides.
C      TIM - Number of years time width bin for subroutine EROSIO
C          out of UNSAT.
C      DENS - Density of soil in upper bin (gm/cm**3)
C      XNUCIN - Initial amount of nuclides to go into subroutine
C           EROSIO. (ci/ft**3)
C      XNCOUT - The nuclide concentration that gets lofted as a
C           result of calculations in EROSIO. (ci)
C      AC - Equilibrium constant used in AQUIFR and is different
C          for each nuclide.
C      CI - The nuclide concentration which is fed into
C          subroutine ATMOS. (ci years/ft**3)
C      WC - Contamination added to water stream. (ci)
C
      DOUBLE PRECISION AC,RI,CIN,PEC,ETA,THETA
      LOGICAL MAXIND
C     OUTPUT FROM AQUIFR DOSE VS. TIME FOR EACH NUCLIDE
      COMMON/ALL/ IPATHZ(4),UD,VOL,DI
      COMMON/DOSER/BEEF,COWS,FACE(3),FVA,NCPY,PRODUC,IP(20),FLOWR
      COMMON/TSTEP/ T(100,45),D(100,45),DDD(100)
C       INPUT TO AQUIFR
      COMMON/AQUA/ XZ,EI,VZ,TI,TZ,RNWV(45)
C  DOSEX,TIS,ITS - SOIL PARAMATERS
C   DOSEE,TIA,ITI - AQUIFER PARAMETERS (DOSE,TIME,NO. OF TIME BINS)
      COMMON/ATM02/ GC(45,20),ACT(45,20)
      COMMON/DAQUA/DOSEX(45,26),TIS(26),ITS,DOSEE(45,11),TIA(11),ITI
      COMMON/EROS/ NUC,TIM,DENS,XNUCIN(45),XNCOUT(45)
      COMMON/HYDRA/ JK,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,
     1 TIMDRY,DD(60),P(52),E(52),W(60),TIMINC,CONQ,HDRY,
     2 HWET,WATL,WATH,CONCOF(60),DNSTY(60),
     3 XD(45,60),SOLFAC(45),ORICNT(45),CUMT,IPASS
      COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      COMMON/FFFFG/AC,RI,CIN,PEC,ETA,THETA
      COMMON/VAR/PAC04,KLSP,RDCHT,RDCSP,RDCRCH,ANC,WNDFRC,HTBR,
     1 FW,R,A,CK5,CK6,CK8,CK9,CK11,CK13,CK1,CK2,CK3,
     2 CK4,ANS,SAIR,NU,FL,ANGL,MAT,ANCWND,ICALL
      COMMON/FDATA/CI(45),VD(45),WC(45),MAXIND
C
      IF(IPZ.EQ.1.OR.IPZ.GT.5.AND.IPZ.LT.9) GO TO 10
      CALL INPUT(IPZ)
   10 CONTINUE
      IF(IPZ.EQ.2) GO TO 500
      IF(IPZ.EQ.5) GO TO 170
      IF(IPZ.EQ.1) GO TO 1
      IF(IPZ.EQ.3) GO TO 600
      IF(IPZ.EQ.4) GO TO 700
      IPASS=0
      IF(IPRNT.GT.0) WRITE(5,11)
   11 FORMAT(2X,13HCALLING HYDRO ,/)
C  UNSAT MODULE -- IPZ = 9
      CALL UNSAT
      RETURN
C  AQUIFER MODULE -- IPZ = 1
    1 IF(ITI.EQ.0) RETURN
```

```
      30            NS=100
      31            TZ=TIA(1)
      32            TI=CUMT-TIA(1)
      33            TZ=TZ/(24.*365.)
      34            TI=TI/(24.*365.)
            C  CONVERTS VELOCITY OF WATER IN AQUIFER TO MILES/YEAR FROM
            C   FEET/DAY    VZ (THIS IS DISPERSION OF NUCLIDES)
      35            VZ=VZ*365.D0/5280.0D0
            C  E1 : FROM CM**2/MIN. - MILES**2/YEAR
      36            E1=E1*60.0D0*24.0D0*365.0D0/(30.48D0**2*5280.0D0**2)
      37            DO 100 I=1,NUMNUC
      38            AC=1./RNWV(I)
      39            IS=I
      40            CALL CNT(NS,IS)
      41       100  CONTINUE
      42            IK=ITI-1
      43            IF(IPRNT.EQ.2) WRITE(6,110) IK
      44       110  FORMAT(1H1,45X,14HAQUIFER OUTPUT,//10X,8HWE HAVE ,I3,23H BLOCKS OF
                   1 TIME (HOURS),/)
      45            IF(IPRNT.EQ.2) WRITE(6,115) (TIA(J),J=1,IK)
      46       115  FORMAT(6E12.4)
      47            DO 125 J=1,IK
      48            TZ=TIA(J)
      49            TI=TIA(J+1)-TIA(J)
      50            TI=TI/(24.*365.)
      51            TZ=TZ/(24.*365.)
      52            IA=0
      53            IB=0
      54            DO 120 I=1,NUMNUC
      55            IF(DOSEE(I,J).EQ.0) GO TO 120
      56            DOSEE(I,J)=DOSEE(I,J)*FL*FW
      57            II=I
      58            IJ=J
      59            IF(IA.EQ.0.AND.IPRNT.GT.0) WRITE(5,12)
      60            IA=1
      61       12   FORMAT(2X,14HCALLING AQUIFR ,/)
      62            CALL AQUIFR(II,IJ)
      63            DO 123 K=2,100
      64            D(K,I)=DDD(K)
      65       123  CONTINUE
      66       120  CONTINUE
      67            DO 350 K=2,100
      68            DO 300 I=1,NUMNUC
      69            IF(D(K,I).EQ.0.) GO TO 300
      70            GO TO 325
      71       300  CONTINUE
      72            GO TO 350
            C  CONVERT TIME FROM HOURS TO YEARS
      73       325  DO 335 I=1,NUMNUC
      74            TI=T(K,I)-T(K-1,I)
      75            TIME=TI
      76            WC(I)=TIME*D(K,I)
      77            IF(IPRNT.EQ.2) WRITE(6,334) (NAME(I,JN),JN=1,2),T(K-1,I),
                   1 TIME,D(K,I),WC(I)
      78       334  FORMAT(2X,2A3,2X,14HINITIAL TIME= ,1PE13.6,
                   1 3X,11HTIME WIDTH= ,1PE12.6,3X,21HDOSE OUT OF AQUIFER= ,1PE12.6,
                   2 3X,17HINTEGRATED DOSE= ,1PE12.6)
      79       335  CONTINUE
```

```
      IF(IB.EQ.0.AND.IPRNT.GT.0) WRITE(5,337)
  337 FORMAT(2X,12HCALLING DOSE ,/)
      IB=1
      CALL DOSET(TIME)
  350 CONTINUE
      DO 355 K=2,100
      DO 355 I=1,NUMNUC
      D(K,I)=0.
  355 CONTINUE
  125 CONTINUE
      RETURN
C   EROSION MODULE  -- IPZ = 5
  170 IF(ITS.EQ.0) RETURN
      DENS=DNSTY(1)
      DO 175 I=1,NUMNUC
      XNCOUT(I)=0
  175 CONTINUE
      NUC=NUMNUC
      IK=ITS-1
      IF(IPRNT.EQ.2) WRITE(6,111) IK
  111 FORMAT(1H1,45X,14HEROSION OUTPUT,//,10X,6HWE HAVE ,I3,
     1 23H BLOCKS OF TIME (HOURS),/)
      IF(IPRNT.EQ.2) WRITE(6,115) (TIS(J),J=1,IK)
      DO 180 I=1,IK
      TIM=(TIS(I+1)-TIS(I))/(365.*24.)
      IC=0
      DO 185 J=1,NUMNUC
      XNUCIN(J)=DOSEX(J,I)/(DD(2)-DD(1))
      IF(XNUCIN(J).GT.0.0) IC=1
  185 CONTINUE
      IF(IC.EQ.0) GO TO 180
      IF(IPRNT.GT.0) WRITE(5,13)
   13 FORMAT(2X,15HCALLING EROSION ,/)
      CALL EROSIO
      TIME=TIM
      DO 190 J=1,NUMNUC
      CI(J)=TIME*XNCOUT(J)
  190  CONTINUE
      IF(IPRNT.GT.0) WRITE(5,187)
  187 FORMAT(2X,13HCALLING ATMOS ,/)
      CALL ATMOS
      IF(IPRNT.GT.0) WRITE(5,337)
      CALL DOSET(TIME)
  180 CONTINUE
      RETURN
C   ATMOSPHERE MODULE  -- IPZ = 2
  500 CONTINUE
      DO 510 I=1,NUMNUC
      CI(I)=ORICNT(I)*VOL*CUNT
  510 CONTINUE
      CALL ATMOS
      CALL DOSET(CUNT)
      RETURN
C   DIRECT MODULE  -- IPZ = 3
  600 CONTINUE
      CALL DIRECT
      RETURN
C   DOSE MODULE  -- IPZ = 4
```

```
      700  CONTINUE
           DO 710 I=1,NUMNUC
           ACT(I,1)=ORICNT(I)*6\/(UD*3.14159*DI**2)
      710  CONTINUE
           IP(1)=1
           CALL DOSET(CUNT)
           RETURN
           END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 14C0 | CK13 | -R | 14C0 | DELW | -R | 11C0 | FLOWR | -R | 5C0 | ITITLE( ) | I | 12C0 | R | -R | 14C0 | VAR | - 14CR |
| ALL | - | 4CR | CK2 | -R | 14C0 | DIRECT | - | 151SU | FVA | -R | 6C0 | JK | -I | 11C0 | RAIN | -R | 11C0 | VD | ( )R 15C0 |
| ANG | -R | 14C0 | CK3 | -R | 14C0 | DOSEB | - | 5CR | GC | ( )R | 8C0 | KLSP | -I | 14C0 | RDCHT | -R | 14C0 | W | ( )R 11C0 |
| ANGL | -R | 14C0 | CK4 | -R | 14C0 | DOUBLE | - | 2F | GNT | - | 40SU | LOGICA | - | 3F | RDCRCH | -R | 14C0 | WATH | -R 11C0 |
| ANGWND | -R | 14C0 | CK5 | -R | 14C0 | DRY | -R | 11C0 | HDAY | -R | 11C0 | MAT | -I | 14C0 | RDCSP | -R | 14C0 | WATL | -R 11C0 |
| ARS | -R | 14C0 | CK6 | -R | 14C0 | E | ( )R | 11C0 | HTBR | -R | 14C0 | N | -I | 12C0 | SAIR | -R | 14C0 | WRDFRC | -R 14C0 |
| AQUA | - | 7CR | CK8 | -R | 14C0 | EROS | - | 10CR | HWET | -R | 11C0 | NCPY | -I | 5C0 | SOLFAC( )R | | 11C0 | XD | ( )R 11C0 |
| AQUIFR | - | 62SU | CK9 | -R | 14C0 | EROS10 | - | 111SU | HYDRA | - | 11CR | ND | -I | 11C0 | TINDRY | -R | 11C0 | XDATA | - 12CR |
| ATM02 | - | 8CR | CORCOF( )R | | 11C0 | EXEC | - | 1SU | ICALL | -I | 14C0 | NU | -I | 14C0 | TININC | -R | 11C0 | XZ | -R 7C0 |
| BEEF | -R | 5C0 | CONC | -R | 11C0 | FACE | ( )R | 5C0 | IN | -I | 11C0 | P | ( )R | 11C0 | TINWET | -R | 11C0 | | |
| CK1 | -R | 14C0 | COMS | -R | 5C0 | FDATA | - | 15CR | INPUT | - | 17SU | PAC84 | -R | 14C0 | TSTEP | - | 6CR | | |
| CK11 | -R | 14C0 | DAQUA | - | 9CR | FFFFC | - | 13CR | IPATHZ( ) | I | 4C0 | PRODUC | -R | 5C0 | UNSAT | - | 27SU | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC | -D | 20B | 13C0 | 38= | | | | | | | | | | | | | | | |
| ACT | ( )R | 8C0 | 135= | | | | | | | | | | | | | | | | |
| ATMOS | - | 110SU | 127SU | | | | | | | | | | | | | | | | |
| CALL | - | 17F | 27F | 40F | 62F | 83F | 111F | 118F | 120F | 127F | 128F | 131F | 138F | | | | | | |
| CI | ( )R | 15C0 | 114= | 126= | | | | | | | | | | | | | | | |
| CIR | -D | 20B | 13C0 | | | | | | | | | | | | | | | | |
| COMMON | - | 4F | 5F | 6F | 7F | 8F | 9F | 10F | 11F | 12F | 13F | 14F | 15F | | | | | | |
| CONT | -R | 11C0 | 32 | 125 | 128AC | 130AC | | | | | | | | | | | | | |
| D | ( )R | 6C0 | 64= | 69 | 76 | 77WR | 87= | | | | | | | | | | | | |
| DD | ( )R | 11C0 | 105 | 105 | | | | | | | | | | | | | | | |
| DDD | ( )R | 6C0 | 64 | | | | | | | | | | | | | | | | |
| DENS | -R | 10C0 | 92= | | | | | | | | | | | | | | | | |
| DI | -R | 4C0 | 135 | | | | | | | | | | | | | | | | |
| DNSTY | ( )R | 11C0 | 92 | | | | | | | | | | | | | | | | |
| DOSEE | ( )R | 9C0 | 55 | 56= | 56 | | | | | | | | | | | | | | |
| DOSET | - | 83SU | 120SU | 128SU | 138SU | | | | | | | | | | | | | | |
| DOSEX | ( )R | 9C0 | 105 | | | | | | | | | | | | | | | | |
| EI | -R | 7C0 | 36= | 36 | | | | | | | | | | | | | | | |
| ETA | -D | 20B | 13C0 | | | | | | | | | | | | | | | | |
| FL | -R | 14C0 | 56 | | | | | | | | | | | | | | | | |
| FW | -R | 14C0 | 56 | | | | | | | | | | | | | | | | |
| I | -I | 37D0 | 38 | 39 | 54D0 | 55 | 56 | 56 | 57 | 64 | 68D0 | 69 | 73D0 | 74 | 74 | 76 | 76 | 77WR | |
| | | 77WR | 77WR | 77WR | 86D0 | 87 | 93D0 | 94 | 101D0 | 102 | 102 | 105 | 124D0 | 125 | 125 | 134D0 | 135 | 135 | |
| IA | -I | 52= | 59 | 60= | | | | | | | | | | | | | | | |
| IB | -I | 53= | 80 | 82= | | | | | | | | | | | | | | | |
| IC | -I | 103= | 106= | 108 | | | | | | | | | | | | | | | |
| IF | - | 16F | 19F | 20F | 21F | 22F | 23F | 25F | 29F | 43F | 45F | 55F | 59F | 69F | 77F | 80F | 91F | 98F | |
| | | 100F | 106F | 108F | 109F | 116F | 119F | | | | | | | | | | | | |
| II | -I | 57= | 62AC | | | | | | | | | | | | | | | | |
| IJ | -I | 58= | 62AC | | | | | | | | | | | | | | | | |
| IK | -I | 42= | 43WR | 45WR | 47D0 | 97= | 98WR | 100WR | 101D0 | | | | | | | | | | |
| IP | ( )I | 5C0 | 137= | | | | | | | | | | | | | | | | |
| IPASS | -I | 11C0 | 24= | | | | | | | | | | | | | | | | |
| IPRNT | -I | 12C0 | 25 | 43 | 45 | 59 | 77 | 80 | 98 | 100 | 109 | 116 | 119 | | | | | | |
| IPZ | -I | 1AC | 16 | 16 | 16 | 17AC | 19 | 20 | 21 | 22 | 25 | | | | | | | | |
| IS | -I | 39= | 40AC | | | | | | | | | | | | | | | | |
| ITI | -I | 9C0 | 29 | 42 | | | | | | | | | | | | | | | |
| ITS | -I | 9C0 | 91 | 97 | | | | | | | | | | | | | | | |
| J | -I | 45WR | 45WR | 47D0 | 48 | 49 | 49 | 55 | 56 | 56 | 58 | 100WR | 100WR | 104D0 | 105 | 105 | 106 | 113D0 | |
| | | 114 | 114 | | | | | | | | | | | | | | | | |
| JR | -I | 77WR | 77WR | | | | | | | | | | | | | | | | |
| K | -I | 63D0 | 64 | 64 | 67D0 | 69 | 74 | 74 | 76 | 77WR | 77WR | 85D0 | 87 | | | | | | |
| MAXIND | -I. | 31C | 15C0 | | | | | | | | | | | | | | | | |

```
NAME     ()I   12CO   77WR
NS       -I    30=    40AC
NUC      -I    10CO   96=
NUMNUC   -I    11CO   37DO   54DO   68DO   73DO   86DO   93DO   96     104DO  113DO  124DO  134DO
ORIGNT   ()R   11CO   125    135
PEC      -D    2DB    13CO
R1       -D    2DB    13CO
RETURN   -     20F    29F    90F    91F    122F   129F   132F   139F
RNWV     ()R   7CO    38
T        ()R   6CO    74     74     77WR
TI       -R    7CO    32=    34=    34     49=    50=    50     74=    75
THETA    -D    2DB    13CO
TIA      ()R   9CO    31     32     45WR   48     49     49
TIM      -R    10CO   102=   112
TIME     -R    75=    76     77WR   83AC   112=   114    120AC
TIS      ()R   9CO    100WR  102    102
TZ       -R    7CO    31=    33=    33     48=    51=    51
UD       -R    4CO    135
VOL      -R    4CO    125
VZ       -R    7CO    35=    35
WC       ()R   15CO   76=    77WR
WRITE    --    25F    43F    45F    59F    77F    80F    98F    100F   109F   116F   119F
XNCOUT   ()R   10CO   94=    114
XNUCIN   ()R   10CO   105=   106
     1   -     21     29*
    10   -     16     18*
    11   -     25WR   26*
    12   -     59WR   61*
    13   -     109WR  110*
   100   -     37DO   41*
   110   -     43WR   44*
   111   -     98WR   99*
   115   -     45WR   46*    100WR
   120   -     54DO   55     66*
   123   -     63DO   65*
   125   -     47DO   89*
   170   -     20     91*
   175   -     93DO   95*
   180   -     101DO  108    121*
   185   -     104DO  107*
   187   -     116WR  117*
   190   -     113DO  115*
   300   -     68DO   69     71*
   325   -     70     73*
   334   -     77WR   78*
   335   -     73DO   79*
   337   -     80WR   81*    119WR
   350   -     67DO   72     84*
   355   -     85DO   86DO   88*
   500   -     19     123*
   510   -     124DO  126*
   600   -     22     130*
   700   -     23     133*
   710   -     134DO  136*
```

```
      SUBROUTINE INPUT(IPZ)
C
C*ABSTRACT: Input routine for Shallow Land Burial.
C
C*AUTHOR: L. ROBERTSON  NOVEMBER 17 , 1980
C
C*TYPE: IO
C
C*PARAMETER DESCRIPTION:
CIN       IPZ - Path number (See subroutine EXEC for details)
C
C*CALLED BY:
C         EXEC
C
C*CALLS TO:
C         NONE
C
C*COMMON BLOCKS:
CNAME       HYDRA
C            *jk, *nd, *in, *numnuc, *delw, *rain, *dry, *timwet, *timdry,
C            *dd, *p, *e, *w, *hdry, *hwet, *watl, *wath, *estart, *estop,
C            *aki, *concof, *dnsty, *xd, *solfac, cumt
CNAME       AQUA
C            *xz, *ei, *vz, *tz, *rnwv
CNAME       VAR
C            *pag84, *klsp, *rdght, *rdgsp, *rdgrgh, *htbr, *fw, *r,
C            *ck5, *ck6,  *ck8, *ck9,  *ck11,  *ck13,
C            *ck1, *ck2, *ck3, *ck4, *sair, *nu, *fl, *angl, *mat, *angwnd
CNAME       VAR1
C            *wind, *erod, *rrough, *wndern, *soilss, *scale, *vegcvr
CNAME       VAR2
C            *u, *ht
CNAME       XDATA
C            *n
CNAME       ATMO1
C            *ns, *ks, *nss, *f, *fr, *ur, *rm, *sh, *sq, *area
CNAME       DOSEB
C            *cows, *fage, *fva, *ncpy, *produc, *ipop, *flowr
CNAME       MDATA
C            *ist, *range, *nsh, *matrl, *thk
C
C*TECHNICAL DESCRIPTION:
C             Reads input necessary to run the scenario selected by the
C             user in the main routine.
C           VARIABLE DESCRIPTIONS:
C              XZ - Length of aquifer (miles)
C              EI - Axial dispersion coefficient (cm**2/min.)
C              VZ - Dispersion of nuclides (feet/day)
C              TZ - Time of leach incident (years)
C              RNWV - Inverse equilibrium constant
C              JK - Number of soil layers used in the geology file.
C              ND - Number of points in the hydraulic conductivity array
C                   as well as in the potential array.
C              IN - Soil layer into which the nuclides are buried.
C              NUMNUC - Number of nuclides.
C              DELW - Water content difference corresponding to table
C                     increments.
C              TIMWET - Rain cycle time. (hours)
```

```
C     TIMDRY - Total time for one complete rain and dry cycle. (hours)
C     RAIN - Rainfall over wet period. (ft./hr)
C     DRY - Evapotranspiration during dry period. (ft./hr)
C           Must input with a negative sign.
C     DD - Depth array of soil column. (feet)
C     P - Potential array (nd entries)
C     E - Hydraulic conductivity array (nd entries)
C     W - Water content as a function of depth.
C     HDRY - Lowest possible pressure with water content.
C     HWET - Highest possible pressure with water content.
C     WATL - Lowest possible water content.
C     WATH - Highest possible water content.
C     CONCOF - Conductivity factor array. (ml/gm)
C     DNSTY - Density of soil layers (gm/cc)
C     XD - Retardation factor array (ml/gm)  An entry for each
C          nuclide for each layer.
C     SOLFAC - Nuclide solubility (gm/cc)
C     PAC84 - Percentage of soil in top layer greater than
C             .84 mm.    limits min = 1    max = 80.
C     KLSP - Knollslope in percent    limits  min = 0.   max = 10.
C            If KLSP gt 0 and CK1 = 1 then will calculate
C            potential soil loss expressed as a percent of that
C            on level ground.  If KLSP = 0 and CK2 = 0, or KLSP gt 0.
C            and CK1 = 0 and CK2 = 0., then the soil loss is
C            set at 100 percent. (minimum point in data)
C            If CK2 = 0 Top of knoll data used.
C               CK2 = 1 Portion of slope where drag velocity and wind
C                       velocity are the same as on top of the knoll.
C     RDGHT - Ridge height (meters)
C             If RDGHT gt 0. and RDGSP gt 0. and rdgrgh = 0,
C             then will calculate RDGRGH.  If RDGRGH gt 0., then
C             RDGHT is not necessary.
C     RDGSP - Ridge spacing (meters)
C             If RDGRGH gt 0., then RDGSP is not necessary.
C     RDGRGH - Ridge roughness (meters)
C              If RDGRT and RDGSP are gt 0. and RDGRGH = 0.,then
C              RDGRGH will be calculated.  limits min = 0. max = 10.
C     HTBR - Barrier height (meters)
C     FW - Field width (meters) if = 0 or gt 5000. , will be
C          set to 5000 feet.
C     R - Equivalent vegetation cover (thousands of equiv. lbs/acre)
C         for limits refer to the following CK's.
C     CK5 - If this parameter is gt 0., then will calculate
C           amount of vegetative cover for flat anchored small
C           grain stubble.
C     CK6 - Used in conjunction with CK5.  If CK5 eq 0., then
C           do not need a value for CK6.  Otherwise use the following
C           criteria:
C              CK6 = 1  flat limits for R = 0 - 14.3
C              CK6 = 0  standing limits for R = 0 - 28.
C                       Using CK6 = 0 results in lower vegetative cover.
C     CK8 - If this parameter gt 0.,then will calculate amount of
C           vegetative cover for live or dead small grain crops in
C           seedling and stooling stage.
C     CK9 - Used in conjunction with CK8.  If CK8 = 0, then do not
C             need a value for CK9.  Otherwise use the following criteria
C                CK9 = 1 seeds in furrow  limits for R  = 0 - 11.75
C                CK9 = 0 seeds on smooth ground. limits for r = 0 - 14.
```

```
C                    Results in lower vegetative cover.
C            CK11 - If this parameter is gt 0., then will calculate amount of
C                   vegetative cover for flat grain sorghum stubble of
C                   average stalk thickness.
C            CK13 - If this parameter is gt 0., then will calculate amount of
C                   vegetative cover for standing flat grain (of HT length)
C                   sorghum stubble of average stalk thickness.
C*******************************************************************************
C     FOR ANY CK5,CK6,CK11,CK13 GT 0., THEN THE HIGHEST VALUE SET WILL
C     MAKE THE VEGETATIVE COVER CALCULATIONS BASED SOLELY ON THAT PARTICULAR
C     COVER.     NO COMBINATIONS ARE ALLOWED..
C*******************************************************************************
C            CK1 - Refer to KLSP for information concerning this variable.
C            CK2 - Refer to KLSP for information concerning this variable.
C            CK3 - Used in subroutine KPRIME. If RDGRGH, RDGHT, and RDGSP
C                  equal 0, then the value for E2 in subroutine COMPUT will
C                  not be reduced.
C            CK4 - Used in subroutine KPRIME. If RDGRGH, RDGHT, RDGSP, and
C                  CK3 equal 0, then the value for E2 in subroutine COMPUT
C                  will be cut in half.
C            SAIR - Percentage amount of soil suspended.
C            NU - Number of entries in wind speed array U.
C            FL - Field length (meters)
C            ANGL - Field angle(degrees, 0=north, 90=east, etc.)
C            MAT - Mean annual temperature (degrees cent.)
C            ANGWND - Direction from which the wind is blowing (degrees)
C            U - Array of wind speeds. (meters/sec)
C            HT - Height of standing grain (meters)
C            N - Number of nuclides.
C            NS - Number of stability categories of interest.
C            KS - Stability class number.
C                 KS = 0  Do all NS categories.
C                 KS GT 0  Do category NS only.
C            NSS - Number of stability categories read in, max = 7.
C            F - Array of wind frequencies (dimensionless)
C            FR - Fraction of time it rains.
C            NR - Number of radial increments, max = 20.
C            RH - Radial distances (meters)
C            SH - Release (or stack) height. (meters)
C            SQ - Stack energy release rate (calories/second)
C            AREA - Area of radial increment. (meters squared)
C            BEEF - Number of beef cattle per km**2
C            COWS - Number of milk cows per km**2
C            FAGE - Age group fraction (child,teen,adult)
C            FVA - Fractional area planted to leafy vegetables.
C            NCPY - Number of crops per year.
C            PRODUC - Food crop production (kg/year per sq. km)
C            IPOP - Population in each radial increment.
C            FLOWR - Water flow rate. (liters/year)
C            IST - Sorce type  1 = point, 2 = line, 3 = volume
C            RANGE - Distance from source (meters)
C            NSH - Number of shielding materials - max = 5
C            MATRL - Array of shielding material id numbers
C                    1 = AL, 2 = FE, 3 = PB, 4 = ordinary concrete,
C                    5 = water
C            THK - Array of shielding thicknesses (meters)
C
      2     COMMON/AQUA/XZ,E1,VZ,T1,TZ,RNWV(45)
```

```
      3     COMMON/HYDRA/ JK,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,
     1 TIMDRY,DD(60),P(52),E(52),W(60),TIMINC,CONQ,HDRY,
     2 HWET,WATL,WATH,CONCOF(60),DNSTY(60),
     3 XD(45,60),SOLFAC(45),ORIGNT(45),CUMT
      4     COMMON/VAR/PAC84,KLSP,RDGHT,RDGSP,RDGRGH,ANG,WNDFRC,HTBR,
     1 FW,R,A,CK5,CK6,CK8,CK9,CK11,CK13,CK1,
     2 CK2,CK3,CK4,ANS,SAIR,NU,FL,ANGL,MAT,ANGWND
      5     COMMON/VAR2/ CFCT,V(10),HT,RHO
      6     COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      7     COMMON/ATM01/NS,KS,NSS,F(10,7),FR,HF,NR,RM(20),
     1 SH,SQ,AREA(20)
      8     COMMON/DOSEB/ BEEF,COWS,FACE(3),FVA,NCPY,PRODUC,IPOP(20),FLOWR
      9     COMMON/MDATA/ IST,RANGE,NSH,MATRL(5),THK(5),TE,DOSE,A1
     10     DIMENSION X(45)
     11     REAL KLSP,MAT
     12     DATA PI/3.14159/
C  WITH THE TIME LIMIT OF INTEREST
     13     IF(IPZ.EQ.3) GO TO 80
     14     IF(IPZ.EQ.2) GO TO 70
     15     IF(IPZ.EQ.5) GO TO 60
     16     IF(IPZ.EQ.4) GO TO 90
     17     OPEN(UNIT=11,DEVICE='DSK',FILE='AQUA.DAT')
     18     READ(11,*) XZ,E1,VZ,FLOWR,(RNWV(I),I=1,NUMNUC)
     19     CLOSE(UNIT=11,DEVICE='DSK')
     20     N=NUMNUC
     21     TZ=CUMT
     22     OPEN(UNIT=10,DEVICE='DSK',FILE='GEOLGY.DAT')
     23     READ(10,20) JK,ND,IN
     24 20  FORMAT(3I3)
     25     READ(10,21) DELW
     26 21  FORMAT(7E11.5)
     27     READ(10,21) RAIN,DRY,TIMWET,TIMDRY
     28     FR=TIMWET/(TIMDRY)
     29     KK=JK+1
     30     READ(10,21) (DD(I),I=1,KK)
     31     READ(10,21) (P(I),I=1,ND)
     32     READ(10,21) (E(I),I=1,ND)
     33     READ(10,21) (W(I),I=1,KK)
     34     READ(10,21) HDRY,HWET,WATL,WATH
     35     LSTART=1
     36 22  READ(10,20) LYR
     37     READ(10,21) (X(I),I=1,NUMNUC)
     38     READ(10,21) XCON,DENSE
     39     DO 23 L=LSTART,LYR
     40     DO 23 NUC=1,NUMNUC
     41     CONCOF(L)=XCON
     42     DNSTY(L)=DENSE
     43     XD(NUC,L)=X(NUC)
     44 23  CONTINUE
     45     IF(LYR.GE.KK) GO TO 24
     46     LSTART=LYR+1
     47     GO TO 22
     48 24  CONTINUE
     49     READ(10,21) (SOLFAC(J),J=1,NUMNUC)
     50     CLOSE(UNIT=10,DEVICE='DSK')
     51     GO TO 90
     52 60  OPEN(UNIT=8,DEVICE='DSK',FILE='EROSIO.DAT')
     53     READ(8,*) NO,PAC84,KLSP,CK1,CK2,RDGHT,RDGSP,RDGRGH,
```

```
     1  CK3,CK4,MAT,ANGL,HTBR,FW,FL,R,CK5,CK6,CK8,CK9,
     2  CK11,CK13,HT,SAIR,(UC(I),I=1,10),ANGWND
      54          FL=FL*39.37/12.
      55          FW=FW*39.37/12.
      56          CLOSE(UNIT=8,DEVICE='DSK')
      57          RETURN
      58    70    OPEN(UNIT=9,DEVICE='DSK',FILE='ATMOS.FIL')
      59          READ(9,30) NS,KS,NSS
      60    30    FORMAT(3I5)
      61          READ(9,*) ((F(I,J),J=1,7),I=1,NSS)
      62    31    FORMAT(7F5.2)
      63          READ(9,*) SH,SQ
      64          IF(NU.GT.0) GO TO 89
      65          READ(9,30) NU
      66          READ(9,31) (U(I),I=1,NU)
      67    89    CLOSE(UNIT=9,DEVICE='DSK')
      68    90    IF(ISW.EQ.1) RETURN
      69          ISW=1
      70          OPEN(UNIT=15,DEVICE='DSK',FILE='DOSE.DAT')
      71          READ(15,30) NR
      72          READ(15,33) (RM(I),I=1,NR)
      73    33    FORMAT(8F10.0)
      74          RI=0.
      75          NRM1=NR-1
      76          IF(NRM1.EQ.0) GO TO 36
      77          DO 35 I=1,NRM1
      78          RO=(RM(I)+RM(I+1))/2.
      79          AREA(I)=PI*(RO**2-RI**2)/(16.*1.E6)
      80          RI=RO
      81    35    CONTINUE
      82          GO TO 37
      83    36    AREA(I)=(PI*(2*RM(I))**2)/(16.*1.E6)
      84          GO TO 38
      85    37    RO=2*RM(NR)-RI
      86          AREA(NR)=PI*(RO**2-RI**2)/(16.*1.E6)
      87    38    CONTINUE
           C  READ DOSE INPUT
      88          READ(15,40) BEEF,COWS,(FACE(I),I=1,3),FVA,MCPY,PRODUC
      89    40    FORMAT(2F7.2,4F4.2,I5,F9.2)
      90          READ(15,41) (IPOP(I),I=1,NR)
      91    41    FORMAT(7I10)
      92          CLOSE(UNIT=15,DEVICE='DSK')
      93          RETURN
      94    80    OPEN(UNIT=20,DEVICE='DSK',FILE='DIRECT.DAT')
      95          READ(20,50) IST,RANGE,NSH,(MATRL(I),I=1,NSH)
      96    50    FORMAT(I1,E12.4,I2,5I1)
      97          READ(20,52) (THK(I),I=1,NSH)
      98    52    FORMAT(6E12.4)
      99          CLOSE(UNIT=20,DEVICE='DSK')
     100          RETURN
     101          END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 4CO | ATMOI | - | 7CN | DOSE | -R | 9CO | ITITLE( )I | 6CO | RF | -R | 7CO | VAR | - | 4CN |
| AI | -R | 9CO | CFCT | -R | 5CO | DOSEB | - | 8CN | MDATA | - | 9CN | RHO | -R | 5CO | VAR2 | - | 5CN |
| ARC | -R | 4CO | CORO | -R | 3CO | HYDRA( | - | 3CN | NAME ( )I | 6CO | TI | -R | 2CO | WNDFRC | -R | 4CO |
| ARS | -R | 4CO | DATA | - | 12F | INPUT( | - | 1SU | ORIGNT( )R | 3CO | TE | -R | 9CO | XDATA | - | 6CN |
| AQUA | - | 2CN | DIMENS | - | 10F | IPRNT: | -I | 6CO | REAL | - | 11F | TIMING | -R | 3CO | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANGL | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| ANGWND | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| AREA | ( )R | 7CO | 79= | 83= | 86= | | | | | | | | | | | | | | |
| BEEF | -R | 8CO | 88RD | | | | | | | | | | | | | | | | |
| CK1 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK11 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK13 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK2 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK3 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK4 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK5 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK6 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK8 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CK9 | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| CLOSE | - | 19F | 50F | 56F | 67F | 92F | 99F | | | | | | | | | | | | |
| COMMON | - | 2F | 3F | 4F | 5F | 6F | 7F | 8F | 9F | | | | | | | | | | |
| CORCOF | ( )R | 3CO | 41= | | | | | | | | | | | | | | | | |
| COWS | -R | 8CO | 88RD | | | | | | | | | | | | | | | | |
| CUNT | -R | 3CO | 21 | | | | | | | | | | | | | | | | |
| DD | ( )R | 9CO | 30RD | | | | | | | | | | | | | | | | |
| DELW | -R | 3CO | 25RD | | | | | | | | | | | | | | | | |
| DENSE | -R | 38RD | 42 | | | | | | | | | | | | | | | | |
| DRSTY | ( )R | 9CO | 42= | | | | | | | | | | | | | | | | |
| DRY | -R | 3CO | 27RD | | | | | | | | | | | | | | | | |
| E | ( )R | 3CO | 32RD | | | | | | | | | | | | | | | | |
| E1 | -R | 2CO | 10RD | | | | | | | | | | | | | | | | |
| F | ( )R | 7CO | 61RD | | | | | | | | | | | | | | | | |
| FACE | ( )R | 8CO | 88RD | | | | | | | | | | | | | | | | |
| FL | -R | 4CO | 53RD | 54= | 54 | | | | | | | | | | | | | | |
| FLOWR | -R | 8CO | 10RD | | | | | | | | | | | | | | | | |
| FR | -R | 7CO | 28= | | | | | | | | | | | | | | | | |
| FVA | -R | 8CO | 88RD | | | | | | | | | | | | | | | | |
| FW | -R | 4CO | 53RD | 55= | 55 | | | | | | | | | | | | | | |
| HDRY | -R | 3CO | 34RD | | | | | | | | | | | | | | | | |
| HT | -R | 5CO | 53RD | | | | | | | | | | | | | | | | |
| HTBR | -R | 4CO | 53RD | | | | | | | | | | | | | | | | |
| HWET | -R | 3CO | 34RD | | | | | | | | | | | | | | | | |
| I | -I | 10RD | 10RD | 30RD | 30RD | 31RD | 31RD | 32RD | 32RD | 33RD | 33RD | 37RD | 37RD | 53RD | 53RD | 61RD | 61RD | 66RD | 66RD |
| | | 66RD | 72RD | 72RD | 77DO | 78 | 78 | 79 | 88RD | 88RD | 90RD | 90RD | 95RD | 95RD | 97RD | 97RD | | | |
| IF | - | 13F | 14F | 15F | 16F | 45F | 64F | 68F | 76F | | | | | | | | | | |
| IH | -I | 3CO | 23RD | | | | | | | | | | | | | | | | |
| IPOP | ( )I | 8CO | 90RD | | | | | | | | | | | | | | | | |
| IPZ | -I | 1AC | 13 | 14 | 15 | 16 | | | | | | | | | | | | | |
| IST | -I | 9CO | 95RD | | | | | | | | | | | | | | | | |
| ISW | -I | 6B | 69= | | | | | | | | | | | | | | | | |
| J | -I | 49RD | 49RD | 61RD | 61RD | | | | | | | | | | | | | | |
| JK | -I | 3CO | 23RD | 29 | | | | | | | | | | | | | | | |
| KK | -I | 29= | 30RD | 33RD | 45 | | | | | | | | | | | | | | |
| KLSP | -R | 4CO | 11RL | 53RD | | | | | | | | | | | | | | | |
| KS | -I | 7CO | 59RD | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. | -I | 39P0 | 41 | 42 | 43 | | | | | | | | | | | | | | |
| ISTART | -I | 38= | 39D0 | 46= | | | | | | | | | | | | | | | |
| LYR | -I | 36RD | 39D0 | 45 | 46 | | | | | | | | | | | | | | |
| MAT | -R | 4C0 | 11RL | 53RD | | | | | | | | | | | | | | | |
| MATRL | ()I | 9C0 | 95RD | | | | | | | | | | | | | | | | |
| N | -I | 6C0 | 20= | | | | | | | | | | | | | | | | |
| NCPY | -I | 8C0 | 88RD | | | | | | | | | | | | | | | | |
| ND | -I | 3C0 | 23RD | 31RD | 32RD | | | | | | | | | | | | | | |
| NR | -I | 7C0 | 71RD | 72RD | 75 | 85 | 86 | 90RD | | | | | | | | | | | |
| NRMI | -I | 75= | 76 | 77D0 | | | | | | | | | | | | | | | |
| NS | -I | 7C0 | 59RD | | | | | | | | | | | | | | | | |
| NSH | -I | 9C0 | 95RD | 95RD | 97RD | | | | | | | | | | | | | | |
| NSS | -I | 7C0 | 59RD | 61RD | | | | | | | | | | | | | | | |
| NU | -I | 4C0 | 53RD | 64 | 65RD | 66RD | | | | | | | | | | | | | |
| NUC | -I | 40D0 | 43 | 43 | | | | | | | | | | | | | | | |
| NUMRUC | -I | 3C0 | 10RD | 20 | 37RD | 40D0 | 49RD | | | | | | | | | | | | |
| OPEN | - | 17F | 22F | 52F | 58F | 70F | 94F | | | | | | | | | | | | |
| P | ()R | 3C0 | 31RD | | | | | | | | | | | | | | | | |
| PAC84 | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| PI | -R | 12DA | 79 | 83 | 86 | | | | | | | | | | | | | | |
| PRODUC | -R | 8C0 | 88RD | | | | | | | | | | | | | | | | |
| R | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| RAIN | -R | 3C0 | 27RD | | | | | | | | | | | | | | | | |
| RANGE | -R | 9C0 | 95RD | | | | | | | | | | | | | | | | |
| RDCHT | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| RDCHCH | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| RDCSP | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| READ | - | 18F | 23F | 25F | 27F | 30F | 31F | 32F | 33F | 34F | 36F | 37F | 38F | 49F | 53F | 59F | 61F | 63F | |
| | | 65F | 66F | 71F | 72F | 88F | 90F | 95F | 97F | | | | | | | | | | |
| RETURN | - | 57F | 60F | 93F | 100F | | | | | | | | | | | | | | |
| RI | -R | 74= | 79 | 80= | 85 | 86 | | | | | | | | | | | | | |
| RR | ()R | 7C0 | 72RD | 78 | 78 | 83 | 85 | | | | | | | | | | | | |
| RRWV | ()R | 2C0 | 18RD | | | | | | | | | | | | | | | | |
| RO | -R | 78= | 79 | 80 | 85= | 86 | | | | | | | | | | | | | |
| SAIR | -R | 4C0 | 53RD | | | | | | | | | | | | | | | | |
| SH | -R | 7C0 | 63RD | | | | | | | | | | | | | | | | |
| SOLFAC | ()R | 3C0 | 49RD | | | | | | | | | | | | | | | | |
| SQ | -R | 7C0 | 63RD | | | | | | | | | | | | | | | | |
| TBK | ()R | 9C0 | 97RD | | | | | | | | | | | | | | | | |
| TIMDRY | -R | 3C0 | 27RD | 28 | | | | | | | | | | | | | | | |
| TIMWET | -R | 3C0 | 27RD | 28 | | | | | | | | | | | | | | | |
| TZ | -R | 2C0 | 21= | | | | | | | | | | | | | | | | |
| U | ()R | 5C0 | 53RD | 66RD | | | | | | | | | | | | | | | |
| VZ | -R | 2C0 | 18RD | | | | | | | | | | | | | | | | |
| W | ()R | 3C0 | 33RD | | | | | | | | | | | | | | | | |
| WATH | -R | 3C0 | 34RD | | | | | | | | | | | | | | | | |
| WATL | -R | 3C0 | 34RD | | | | | | | | | | | | | | | | |
| X | ()R | 10D1 | 37RD | 43 | | | | | | | | | | | | | | | |
| XCON | -R | 30RD | 41 | | | | | | | | | | | | | | | | |
| XD | ()R | 3C0 | 43= | | | | | | | | | | | | | | | | |
| XZ | -R | 2C0 | 18RD | | | | | | | | | | | | | | | | |
| 20 | - | 23RD | 24* | 36RD | | | | | | | | | | | | | | | |
| 21 | - | 25RD | 26* | 27RD | 30RD | 31RD | 32RD | 33RD | 34RD | 37RD | 38RD | 49RD | | | | | | | |
| 22 | - | 36* | 47 | | | | | | | | | | | | | | | | |
| 23 | - | 39D0 | 40D0 | 44* | | | | | | | | | | | | | | | |
| 24 | - | 45 | 48* | | | | | | | | | | | | | | | | |
| 30 | - | 59RD | 60* | 65RD | 71RD | | | | | | | | | | | | | | |
| 31 | - | 62* | 66RD | | | | | | | | | | | | | | | | |

```
   33  -    72RD    73*
   35  -    77DO    81*
   36  -    76      83*
   37  -    82      85*
   38  -    84      87*
   40  -    88RD    89*
   41  -    90RD    91*
   50  -    95RD    96*
   52  -    97RD    98*
   60  -    15      52*
   70  -    14      58*
   80  -    13      94*
   89  -    64      67*
   90  -    16      51      68*
```

```
      SUBROUTINE OUTPUT(IFLAG)
C
C*ABSTRACT: Output routine for Shallow Land Burial.
C
C*AUTHOR: L. ROBERTSON NOVEMBER 17 , 1980
C
C*TYPE: IO
C
C*PARAMETER DESCRIPTION:
CIN         IFLAG - Path number. If IFLAG = 0, then will print the total
C                   scenario doses for all paths.
C
C*CALLED BY:
C           BURYIT
C
C*CALLS TO:
C           SUMDOS
C
C*COMMON BLOCKS:
CNAME       XDATA
C            name, ititle
CNAME       HYDRA
C            numnuc
CNAME       OUTD
C            dosei, dosej, dosek, dosel, dosem, dosett
CNAME       ATMOI
C            nj, rm
CNAME       MDATA
C            dose
CNAME       LDATA
C            *tdose, *tdosep, *tdosei, *tdosej, *tdosek, *tdosem, *tdosel
CNAME       FDATA
C            maxind
C
C*TECHNICAL DESCRIPTION:
C             Writes results of the scenario selected by the user.
C          VARIABLE DESCRIPTIONS:
C             TDOSE - Total direct dose for the scenario.
C             TDOSEP - Total cumulative dose for the scenario.
C             TDOSEI - Total dose by nuclide for the scenario.
C             TDOSEJ - Total dose by distance increment for the scenario.
C             TDOSEK - Total dose by pathway for the scenario.
C             TDOSEM - Total dose by age group for the scenario.
C             TDOSEL - Total dose by organ for the scenario.
C
      LOGICAL MAXIND
      DIMENSION A1(3),A2(3)
      COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      COMMON/HYDRA/ JK,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,
     1 DD(60),P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,
     2 CONCOF(60),DRSTY(60),XD(45,60),SOLFAC(45),ORIGNT(45),
     3 CUMT,IPASS
      COMMON/OUTD/ DOSEI(45),DOSEJ(20),DOSEK(9),DOSEL(9),
     1 DOSEM(3),DOSETT
      COMMON/ATMOI/NS,KS,NSS,F(10,7),FR,RF,NJ,RM(20)
      COMMON/MDATA/ IS,R,NST,MAT(5),THK(5),T,DOSE,A
      COMMON/LDATA/TDOSE,TDOSEP,TDOSEI(45),TDOSEJ(20),TDOSEK(9),
     1 TDOSEM(3),TDOSEL(9)
```

```
      COMMON /FDATA/ CI(45),VD(45),WC(45),MAXIND
      DIMENSION IPATH(4,9),IORG(2,9),IAGE(3)
      DATA A1/3H A ,3H A ,3HAN /,A2/5HCHILD,5HTEEN ,5HADULT/
      DATA IPATH/5HCLOUD,5H SHIN,1HE,1H ,5HGROUN,5HD SHI,2HNE,1H ,
     +  5HDIREC,5HT INH,5HALATI,2HON,5HRESUS,5H. INH,5HALATI,2HON,
     +  5HWATER,5H INGE,5HSTION,1H ,5HLEAFY,5H VEG ,5HINGES,4HTION,
     +  5HROOT ,5HINGES,4HTION,1H ,5HMILK ,5HINGES,4HTION,1H ,
     +  5HBEEF ,5HINGES,4HTION,1H /
      DATA IAGE/5HCHILD,4HTEEN,5HADULT/
      DATA IORG/5HWHOLE,5H BODY,4HBONE,1H ,5HLIVER,1H ,
     1 5HKIDNE,1HY,5HGONAD,1H ,4HLUNG,1H ,5HG.I.T,4HRACT/
     2 5HTHYRO,2HID,4HSKIN,1H /
        IF(IFLAG.EQ.0) GO TO 200
      I = 1
      J = 0
      IF (MAXIND) CALL SUMDOS(I,J,K,L,M,D)
       TDOSE=TDOSE+DOSE
       TDOSEP=TDOSEP+DOSETT
       DO 10 I=1,NUMNUC
       TDOSEI(I)=DOSEI(I)+TDOSEI(I)
   10  CONTINUE
       DO 11 I=1,NJ
       TDOSEJ(I)=DOSEJ(I)+TDOSEJ(I)
   11  CONTINUE
       DO 12 I=1,9
       TDOSEK(I)=DOSEK(I)+TDOSEK(I)
       TDOSEL(I)=DOSEL(I)+TDOSEL(I)
   12  CONTINUE
       DO 13 I=1,3
       TDOSEM(I)=DOSEM(I)+TDOSEM(I)
   13  CONTINUE
       IF(.NOT.MAXIND) GO TO 15
       TA1=A1(M)+TA1
       TA2=A2(M)+TA2
       TRM=RM(J)+TRM
   15  IF (MAXIND) WRITE (6,103) IFLAG,(ITITLE(I),I=1,12)
  103  FORMAT(1H1/45X,17HDOSE OUTPUT (REM),/45X,8HFOR PATH,I2,/45X,12A5/)
       IF(.NOT.MAXIND) WRITE(6,104) IFLAG,(ITITLE(I),I=1,12)
  104  FORMAT(1H1,/45X,24HDOSE OUTPUT (PERSON-REM) ,/45X,8HFOR PATH,
     1 I2,/45X,12A5,/)
       IF (.NOT.MAXIND) WRITE(6,105) DOSETT
  105  FORMAT(30X,30HCUMULATIVE POPULATION DOSE     ,1PE10.2)
       IF (MAXIND) WRITE (6,106) DOSETT
  106  FORMAT (30X,23HMAXIMUM INDIVIDUAL DOSE ,1PE10.2)
       WRITE(6,107) DOSE
  107  FORMAT(36X,20HDIRECT EXPOSURE DOSE,4X,1PE10.2)
       IF (MAXIND) WRITE (6,108) A1(M),A2(M),RM(J)
  108  FORMAT (//19X,27HMAXIMUM DOSE INDIVIDUAL IS ,A3,A5,I2H AT DISTANCE,
     +    F7.0,7H METERS/)
       IF (.NOT.MAXIND) WRITE(6,110)
  110  FORMAT(//,19X,35HTOTAL POPULATION DOSE BREAKDOWN BY ,
     2 28HRADIONUCLIDE, DISTANCE CELL,/19X,19HDOSE PATHWAY, BODY ,
     3 31HORGAN AND POPULATION AGE GROUP.)
       IF (MAXIND) WRITE (6,111)
  111  FORMAT (//19X,37HMAXIMUM INDIVIDUAL DOSE BREAKDOWN BY ,
     +    13HRADIONUCLIDE,/19X,23HDOSE PATHWAY, AND BODY ,
     +    6HORGAN.)
       WRITE(6,130)
```

```
      56      130  FORMAT(//,25X,12HRADIONUCLIDE)
      57           WRITE(6,116) ((NAME(I,J),J=1,2),DOSEI(I),I=1,NUMNUC)
      58      116  FORMAT(24X,2A3,2X,1PE10.2,5X,2A3,2X,1PE10.2)
      59           IF (.NOT.MAXIND) WRITE(6,131)
      60      131  FORMAT(//,25X,11HDISTANCE(M) )
      61           IF (.NOT.MAXIND) WRITE(6,120) (RM(I),DOSEJ(I),I=1,NJ)
      62      120  FORMAT(24X,0PF6.0,2X,1PE10.2,5X,0PF6.0,2X,1PE10.2)
      63      117  FORMAT(20X,4A5,1X,1PE10.2,5X,4A5,1PE10.2)
      64           WRITE(6,132)
      65      132  FORMAT(//,25X,4HPATH )
      66           WRITE(6,117) ((IPATH(J,I),J=1,4),DOSEK(I),I=1,9)
      67      118  FORMAT(27X,2A5,1X,1PE10.2,5X,2A5,1X,1PE10.2)
      68           WRITE(6,133)
      69      133  FORMAT(//,25X,5HORGAN)
      70           WRITE(6,118) ((IORG(J,I),J=1,2),DOSEL(I),I=1,9)
      71           IF (.NOT.MAXIND) WRITE(6,134)
      72      134  FORMAT(//,25X,9HAGE GROUP )
      73           IF (.NOT.MAXIND) WRITE(6,119) (IAGE(I),DOSEM(I),I=1,3)
      74      119  FORMAT(25X,A5,2X,1PE10.2,5X,A5,2X,1PE10.2)
      75           RETURN
      76      200  IF(MAXIND) WRITE(6,113) (ITITLE(I),I=1,12)
      77      113  FORMAT(1H1,/45X,17HDOSE OUTPUT (REM) ,/45X,
     1 13HFOR ALL PATHS,/45X,12A5,/)
      78           IF(.NOT.MAXIND) WRITE(6,114) (ITITLE(I),I=1,12)
      79      114  FORMAT(1H1,/,45X,24HDOSE OUTPUT (PERSON-REM) ,/45X,
     1 13HFOR ALL PATHS,/45X,12A5,/)
      80           IF(.NOT.MAXIND) WRITE(6,105) TDOSEP
      81           IF(MAXIND) WRITE(6,106) TDOSEP
      82           WRITE(6,107) TDOSE
      83           IF(MAXIND) WRITE(6,108) TA1,TA2,TRM
      84           IF(.NOT.MAXIND) WRITE(6,110)
      85           IF(MAXIND) WRITE(6,111)
      86           WRITE(6,130)
      87           WRITE(6,116) ((NAME(I,J),J=1,2),TDOSEI(I),I=1,NUMNUC)
      88           IF(.NOT.MAXIND) WRITE(6,131)
      89           IF(.NOT.MAXIND) WRITE(6,120) (RM(I),TDOSEJ(I),I=1,NJ)
      90           WRITE(6,132)
      91           WRITE(6,117) ((IPATH(J,I),J=1,4),TDOSEK(I),I=1,9)
      92           WRITE(6,133)
      93           WRITE(6,118) ((IORG(J,I),J=1,2),TDOSEL(I),I=1,9)
      94           IF(.NOT.MAXIND) WRITE(6,134)
      95           IF(.NOT.MAXIND) WRITE(6,119) (IAGE(I),TDOSEM(I),I=1,3)
      96           RETURN
      97           END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 8C0 | DELW | -R | 5C0 | HYDRA( | - | 9CN | LDATA | - | 9CN | ORIGNT( | )R | 5C0 | T | -R | 8C0 | WC | ()R 10C0 |
| ATM91 | - | 7CN | DNSTY | ()R | 6C0 | IN | -I | 5C0 | LOCICA | - | 2F | OUTD | - | 6CN | THK | ()R | 8C0 | XD | ()R 5C0 |
| CALL | - | 19F | DRY | -R | 5C0 | IPASS- | -I | 5C0 | MAT | ()I | 8C0 | OUTPUT | - | 1SU | TIMDRY | -R | 5C0 | XDATA | - 4CN |
| CI | ()R | 10C0 | E | ()R | 5C0 | IPRNT | -I | 4C0 | MDATA | - | 8CN | P | ()R | 6C0 | TIMINC | -R | 5C0 | | |
| CONCOF | ()R | 5C0 | F | ()R | 7C0 | IS | -I | 8C0 | N | -I | 4C0 | R | -R | 8C0 | TIMWET | -R | 5C0 | | |
| CORQ | -R | 5C0 | FDATA | - | 10CN | JK | -I | 5C0 | ND | -I | 5C0 | RAIN | -R | 5C0 | VD | ()R | 10C0 | | |
| CURF | -R | 5C0 | FR | -R | 7C0 | K | -I | 19AC | NS | -I | 7C0 | RF | -R | 7C0 | W | ()R | 5C0 | | |
| D | -R | 19AC | HDRY | -R | 5C0 | KS | -I | 7C0 | NSS | -I | 7C0 | SOLFAC( | )R | 5C0 | WATH | -R | 5C0 | | |
| DD | ()R | 5C0 | HWET | -R | 5C0 | L | -I | 19AC | NST | -I | 8C0 | SUMDOS | - | 19SU | WATL | -R | 5C0 | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | ()R | 3D1 | 12DA | 36 | 49WR | | | | | | | | | | | | |
| A2 | ()R | 3D1 | 12DA | 37 | 49WR | | | | | | | | | | | | |
| COMMON | - | 4F | 5F | 6F | 7F | 8F | 9F | 10F | | | | | | | | | |
| DATA | - | 12F | 13F | 14F | 15F | | | | | | | | | | | | |
| DIMENS | - | 3F | 11F | | | | | | | | | | | | | | |
| DOSE | -R | 8C0 | 20 | 47WR | | | | | | | | | | | | | |
| DOSEI | ()R | 6C0 | 23 | 57WR | | | | | | | | | | | | | |
| DOSEJ | ()R | 6C0 | 26 | 61WR | | | | | | | | | | | | | |
| DOSEK | ()R | 6C0 | 29 | 66WR | | | | | | | | | | | | | |
| DOSEL | ()R | 6C0 | 30 | 70WR | | | | | | | | | | | | | |
| DOSEM | ()R | 6C0 | 33 | 73WR | | | | | | | | | | | | | |
| DOSETT | -R | 6C0 | 21 | 43WR | 45WR | | | | | | | | | | | | |
| I | -I | 17= | 19AC | 22D0 | 23 | 23 | 23 | 25D0 | 26 | 26 | 26 | 28D0 | 29 | 29 | 29 | 30 | 30 | 30 |
| | | 32D0 | 33 | 35 | 33 | 39WR | 39WR | 41WR | 41WR | 57WR | 57WR | 57WR | 61WR | 61WR | 61WR | 66WR | 66WR | 66WR |
| | | 70WR | 70WR | 70WR | 73WR | 73WR | 73WR | 76WR | 76WR | 70WR | 70WR | 87WR | 87WR | 87WR | 89WR | 89WR | 89WR | 91WR |
| | | 91WR | 91WR | 93WR | 93WR | 93WR | 95WR | 95WR | 95WR | | | | | | | | | |
| IACE | ()I | 11D1 | 14DA | 73WR | 95WR | | | | | | | | | | | | | |
| IF | - | 16F | 19F | 35F | 39F | 41F | 43F | 45F | 49F | 51F | 53F | 59F | 61F | 71F | 73F | 76F | 78F | 80F |
| | | 81F | 83F | 84F | 85F | 88F | 89F | 94F | 95F | | | | | | | | | |
| IFLAG | -I | 1AC | 16 | 39WR | 41WR | | | | | | | | | | | | | |
| IORC | ()I | 11D1 | 15DA | 70WR | 93WR | | | | | | | | | | | | | |
| IPATH | ()I | 11D1 | 13DA | 66WR | 91WR | | | | | | | | | | | | | |
| ITITLE | ()I | 4C0 | 39WR | 41WR | 76WR | 78WR | | | | | | | | | | | | |
| J | -I | 18= | 19AC | 38 | 49WR | 57WR | 57WR | 66WR | 66WR | 70WR | 70WR | 87WR | 87WR | 91WR | 91WR | 93WR | 93WR | |
| K | -I | 19AC | 36 | 37 | 49WR | 49WR | | | | | | | | | | | | |
| MAXIND | -I | 21C | 10C0 | 19 | 35 | 39 | 41 | 43 | 45 | 49 | 51 | 53 | 59 | 61 | 71 | 73 | 76 | 78 |
| | | 80 | 81 | 83 | 84 | 85 | 88 | 89 | 94 | 95 | | | | | | | | |
| NAME | ()I | 4C0 | 57WR | 87WR | | | | | | | | | | | | | | |
| NJ | -I | 7C0 | 25D0 | 61WR | 89WR | | | | | | | | | | | | | |
| NUMBUC | -I | 5C0 | 22D0 | 57WR | 87WR | | | | | | | | | | | | | |
| RETURN | - | 75F | 96F | | | | | | | | | | | | | | | |
| RH | ()R | 7C0 | 38 | 49WR | 61WR | 89WR | | | | | | | | | | | | |
| TA1 | -R | 36= | 36 | 83WR | | | | | | | | | | | | | | |
| TA2 | -R | 37= | 37 | 85WR | | | | | | | | | | | | | | |
| TDOSE | -R | 9C0 | 20= | 20 | 82WR | | | | | | | | | | | | | |
| TDOSEI | ()R | 9C0 | 23= | 23 | 87WR | | | | | | | | | | | | | |
| TDOSEJ | ()R | 9C0 | 26= | 26 | 89WR | | | | | | | | | | | | | |
| TDOSEK | ()R | 9C0 | 29= | 29 | 91WR | | | | | | | | | | | | | |
| TDOSEL | ()R | 9C0 | 30= | 30 | 93WR | | | | | | | | | | | | | |
| TDOSEM | ()R | 9C0 | 33= | 33 | 95WR | | | | | | | | | | | | | |
| TDOSEP | -R | 9C0 | 21= | 21 | 80WR | 81WR | | | | | | | | | | | | |
| TRR | -R | 38= | 38 | 83WR | | | | | | | | | | | | | | |
| WRITE | - | 39F | 41F | 43F | 45F | 47F | 49F | 51F | 53F | 55F | 57F | 59F | 61F | 64F | 66F | 68F | 70F | 71F |
| | | 73F | 76F | 78F | 80F | 81F | 82F | 83F | 84F | 85F | 86F | 87F | 88F | 89F | 90F | 91F | 92F | 93F |
| | | 94F | 95F | | | | | | | | | | | | | | | |
| 10 | - | 22D0 | 24= | | | | | | | | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 11 | - | 2500 | 27* | | |
| 12 | - | 2800 | 31* | | |
| 13 | - | 3200 | 34* | | |
| 15 | - | 35 | 39* | | |
| 103 | - | 39WR | 40* | | |
| 104 | - | 41WR | 42* | | |
| 105 | - | 43WR | 44* | 80WR | |
| 106 | - | 45WR | 46* | 81WR | |
| 107 | - | 47WR | 48* | 82WR | |
| 108 | - | 49WR | 50* | 83WR | |
| 110 | - | 51WR | 52* | 84WR | |
| 111 | - | 53WR | 54* | 85WR | |
| 113 | - | 76WR | 77* | | |
| 114 | - | 78WR | 79* | | |
| 116 | - | 57WR | 58* | 87WR | |
| 117 | - | 63* | 66WR | 91WR | |
| 118 | - | 67* | 70WR | 93WR | |
| 119 | - | 73WR | 74* | 95WR | |
| 120 | - | 61WR | 62* | 89WR | |
| 130 | - | 55WR | 56* | 86WR | |
| 131 | - | 59WR | 60* | 88WR | |
| 132 | - | 64WR | 65* | 90WR | |
| 133 | - | 68WR | 69* | 92WR | |
| 134 | - | 71WR | 72* | 94WR | |
| 200 | - | 16 | 76* | | |

```
      SUBROUTINE PREDOS
C
C*ABSTRACT: This routine sets up the nuclide information needed in UNSAT
C           and AQUIFR.
C
C*AUTHOR: L. ROBERTSON NOVEMBER 17 , 1980
C
C*TYPE: IO
C
C*CALLED BY:
C           BURYIT
C
C*CALLS TO:
C          NONE
C
C*COMMON BLOCKS:
CNAME      XDATA
C           *name
CNAME      HDATA
C           *half
CNAME      HYDRA
C           *numnuc
CNAME      NDATA
C           iid, *dosfac, *ge
CNAME      EDATA
C           *biv, *fm, *ff
CNAME      FDATA
C           *vd
C
C*TECHNICAL DESCRIPTION:
C             By comparing the names of the nuclides the user provides with the
C             name that are on the random access file, data for each
C             nuclide is produced.
C          VARIABLE DESCRIPTIONS:
C             HALF - Decay constant of each nuclide
C             CE - Gamma energy (10 energy groups) for each nuclide
C             DOSFAC - Dose factors to be used by subroutine DOSET
C             BIV - Food concentration factor (dimensionless)
C             FM - Milk concentration factor. (days/liter)
C             FF - Meat concentration factor (days/kg)
C             VD - Deposition velocity for each isotope (meters/sec)
C
      LOGICAL MAXIND
      COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      COMMON/HDATA/ HALF(45)
      COMMON/HYDRA/ JK,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,
     1 DD(60),P(52),E(52),W(60),TIMING,CONQ,HDRY,HWET,WATL,WATH,
     2 CONCOF(60),DNSTY(60),XD(45,60),SOLFAC(45),ORICNT(45),CUMT,IPASS
      COMMON/NDATA/ DOSFAC(45,8,9),GE(45,10),IID(45)
      COMMON/EDATA/ BIV(45),FM(45),FF(45)
      COMMON/FDATA/CI(45),VD(45),WC(45),MAXIND
      DIMENSION NAMEJ(351,2),NN(2)
      DIMENSION PBIV(100),PFF(100),PFM(100)
      DATA PBIV/4.8E+00,5.0E-02,8.3E-04,4.2E-04,1.3E-01,
     1 5.5E+00,3.8E-01,1.6E+00,6.5E-04,1.4E-01,5.2E-02,
     2 1.3E-01,1.8E-04,1.5E-04,1.1E+00,5.9E-01,5.0E+00,
     3 6.0E-01,3.6E-01,3.6E-03,1.1E-03,5.4E-05,1.3E-03,
     4 2.5E-04,2.9E-02,6.6E-04,9.4E-03,1.9E-02,1.2E-01,
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     5 4.0E-01,2.5E-04,1.0E-01,1.0E-02,1.3E+00,7.6E-01,
     6 3.0E+00,1.3E-01,1.7E-02,2.6E-03,1.7E-04,9.4E-03,
     7 1.2E-01,2.5E-01,5.0E-02,1.3E+01,5.0E+00,1.5E-01,
     8 1.5E+00,2.5E-01,2.5E-01,1.1E-02,1.3E+00,2.0E-02,
     9 1.0E+01,1.0E-02,5.0E-03,2.5E-03,2.5E-03,2.5E-03,
     + 2.4E-03,2.5E-03,2.5E-03,2.5E-03,2.6E-03,2.6E-03,
     + 2.5E-03,2.6E-03,2.5E-03,2.6E-03,2.5E-03,2.6E-03,
     + 1.7E-04,6.3E-03,1.8E-02,2.5E-01,5.0E-02,1.3E+01,
     + 5.0E-01,2.5E-03,3.8E-01,2.5E-01,6.8E-02,1.5E-01,
     + 1.0E+00,2.5E-01,3.5E+00,1.0E-02,3.1E-04,2.5E-03,
     + 4.2E-03,2.5E-03,2.5E-13,2.5E-03,2.5E-04,2.5E-04,
     + 2.5E+00,2.5E+00,2.5E+00,2.5E+00,2.5E+00/
    12  DATA PFF/1.2E-02,2.0E-02,1.0E-02,1.0E-03,8.0E-04,
     + 3.1E-02,7.7E-02,1.6E-02,1.5E-01,2.0E-02,3.0E-02,
     + 5.0E-03,1.5E-03,4.0E-05,4.6E-02,1.0E-01,8.0E-02,
     + 2.0E-02,1.8E-02,7.2E-04,1.6E-02,3.1E-02,2.3E-03,
     + 2.4E-03,8.0E-04,4.0E-02,1.3E-02,5.3E-03,8.0E-03,
     + 3.0E-02,1.3E+00,2.0E+01,2.0E-03,1.5E-02,2.6E-02,
     + 2.0E-02,3.1E-02,6.0E-04,4.6E-03,3.4E-02,2.8E-01,
     + 8.0E-03,4.0E-01,4.0E-01,1.5E-03,4.0E-03,1.7E-02,
     + 5.3E-04,8.0E-03,8.0E-02,1.2E-03,7.7E-02,2.9E-03,
     + 2.0E-02,4.0E-03,3.2E-03,2.0E-04,1.2E-03,4.7E-03,
     + 3.3E-03,4.8E-03,5.0E-03,4.8E-03,3.6E-03,4.4E-03,
     + 5.3E-03,4.4E-03,4.0E-03,4.4E-03,4.0E-03,4.4E-03,
     + 4.0E-01,1.6E+00,1.3E-03,8.0E-03,4.9E-01,1.5E-03,
     + 4.0E-03,8.0E-03,2.6E-01,4.0E-02,2.9E-04,1.3E-02,
     + 2.0E+00,8.0E+00,2.0E-02,2.0E+02,3.4E-02,8.0E+02,
     + 4.8E+02,8.0E+02,4.0E-02,2.0E-04,1.0E-06,3.6E-06,
     + 8.0E+02,8.0E+02,8.0E+02,8.0E+02,8.0E+02/
    13  DATA PFM/1.0E-02,2.0E-02,5.0E-02,9.1E-07,1.5E-03,
     + 1.2E-02,2.3E-02,2.0E-02,1.1E-03,2.0E-02,4.0E-02,
     + 3.9E-03,2.0E-04,2.0E-05,2.5E-02,1.6E-02,1.7E-02,
     + 2.0E-02,7.2E-03,1.1E-02,5.0E-06,1.0E-02,2.0E-05,
     + 2.2E-03,2.5E-04,1.2E-03,1.0E-03,6.7E-03,1.4E-02,
     + 3.9E-02,5.0E-05,5.0E-04,6.2E-05,4.0E-03,2.0E-02,
     + 2.0E-02,3.0E-02,8.0E-04,1.0E-05,5.0E-06,2.5E-03,
     + 7.5E-03,2.5E-02,1.0E-06,1.0E-02,1.0E-02,5.0E-02,
     + 1.0E-03,1.0E-04,1.2E-03,1.1E-04,1.0E-03,6.0E-03,
     + 2.0E-02,1.2E-02,4.0E-04,5.0E-06,1.0E-04,5.0E-06,
     + 5.0E-06,5.0E-06,5.0E-06,5.0E-06,5.0E-06,5.0E-06,
     + 5.0E-06,5.0E-06,5.0E-06,5.0E-06,5.0E-06,5.0E-06,
     + 5.0E-06,2.8E-06,5.0E-04,1.3E-03,5.0E-03,2.0E-06,
     + 5.0E-03,5.3E-06,4.7E-04,1.9E-03,2.6E-04,5.0E-04,
     + 3.4E-04,5.0E-02,3.0E-02,5.0E-02,4.5E-04,5.0E-06,
     + 5.0E-06,5.0E-06,6.1E-04,5.0E-06,1.0E-07,4.1E-07,
     + 5.0E-06,1.5E-06,1.5E-06,1.5E-06,1.5E-06/
    14  OPEN(UNIT=2,DEVICE='DSK',FILE='NUCNAM.FIL')
    15  READ(2,100) ((NAMEJ(I,J),J=1,2),I=1,351)
    16 100  FORMAT(2A3)
    17  CLOSE(UNIT=2,DEVICE='DSK')
    18  OPEN(UNIT=1,DEVICE='DSK',FILE='NUCDAT.FIL',ACCESS='RANDOM',
       1 MODE='BINARY',RECORD SIZE=86)
    19  KK=1
    20  DO 11 K=1,NUMNUC
    21  DO 10 J=1,351
    22  IF(NAMEJ(J,1).NE.NAME(K,1)) GO TO 10
    23  IF(NAMEJ(J,2).NE.NAME(K,2)) GO TO 10
    24  JJ=J
```

```
      25          READ(1'JJ) IID(KK),(NN(JL),JL=1,2),HALF(KK),
     1 (CE(KK,JL),JL=1,10),((DOSFAC(KK,JKL,JL),JL=1,9),JKL=1,8)
      26          IF(NN(1).NE.NAME(K,1)) STOP 20
      27          IF(NN(2).NE.NAME(K,2)) STOP 20
      28          IF(HALF(KK).LT.0.) GO TO 11
      29          NAME(KK,1)=NAME(K,1)
      30          NAME(KK,2)=NAME(K,2)
      31          IEL=IID(KK)/10000
      32          BIV(KK)=PBIV(IEL)
      33          FF(KK)=PFF(IEL)
      34          FM(KK)=PFM(IEL)
      35          VD(KK)=0.01
      36          IF(IEL.EQ.36.OR.IEL.EQ.54.OR.IEL.EQ.86) VD(KK)=0.
      37          KK=KK+1
      38          GO TO 11
      39       10 CONTINUE
      40          WRITE(6,15) (NAME(K,JKL),JKL=1,2)
      41       15 FORMAT(2X,2A3,25H IS NOT ON NUCLIDE LIST.  /)
               C   STOP 21
      42       11 CONTINUE
      43          NUMNUC=KK-1
      44          RETURN
      45          END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CI | ()R | 6C0 | DUSTY | ()R | 6C0 | HDATA | - | 4CN | ITITLE | ()I | 3C0 | ORIENT | ()R | 5C0 | TIMING | -R | 5C0 | XD | ()R | 6C0 |
| CLOSE | - | 17F | DUSFAC | ()R | 6C0 | HDRY | -R | 5C0 | JJ | -I | 24* | P | ()R | 5C0 | TIMWET | -R | 5C0 | XDATA | - | 9CN |
| CONCOF | ()R | 3C0 | DAY | -R | 5C0 | HWET | -R | 5C0 | JK | -I | 6C0 | PREDOS | - | 1SU | W | ()R | 6C0 | | | |
| CORO | -R | 5C0 | E | ()R | 5C0 | HYDRA | - | 5CN | LOCICA | - | 2F | RAIN | -R | 5C0 | WATH | -R | 5C0 | | | |
| CURT | -R | 5C0 | EDATA | - | 7CN | IN | -I | 5C0 | M | -I | 3C0 | RETURN | - | 44F | WATL | -R | 5C0 | | | |
| DB | ()R | 5C0 | FDATA | - | 0CN | IPASS | -I | 5C0 | ND | -I | 6C0 | SOLFAC | ()R | 5C0 | WC | ()R | 0C0 | | | |
| DELW | -R | 5C0 | GE | ()R | 6C0 | IPRNT | -I | 3C0 | NDATA | - | 6CN | TIMDRY | -R | 6C0 | WRITE | - | 40F | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BIV | ()R | 7C0 | 32* | | | | | | | | | | |
| COMMON | - | 3F | 4F | 5F | 6F | 7F | 8F | | | | | | |
| DATA | - | 11F | 12F | 13F | | | | | | | | | |
| DIMENS | - | 9F | 10F | | | | | | | | | | |
| FF | ()R | 7C0 | 33* | | | | | | | | | | |
| FH | ()R | 7C0 | 34* | | | | | | | | | | |
| HALF | ()R | 4C0 | 20 | | | | | | | | | | |
| I | -I | 15R0 | 15R0 | | | | | | | | | | |
| IEL | -I | 31* | 32 | 33 | 34 | 36 | 36 | 36 | | | | | |
| IF | - | 22F | 23F | 26F | 27F | 28F | 36F | | | | | | |
| IID | ()I | 6C0 | 31 | | | | | | | | | | |
| J | -I | 15R0 | 15R0 | 21D0 | 22 | 23 | 24 | | | | | | |
| JKL | -I | 40WR | 40WR | | | | | | | | | | |
| K | -I | 20D0 | 22 | 23 | 26 | 27 | 29 | 30 | 40WR | | | | |
| KK | -I | 19* | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37* | 37 | 43 |
| MAXIND | -L | 21L | 0C0 | | | | | | | | | | |
| NAME | ()I | 3C0 | 22 | 23 | 26 | 27 | 29* | 29 | 30* | 30 | 40WR | | |
| NAMEJ | ()I | 9D1 | 15R0 | 22 | 23 | | | | | | | | |
| NN | ()I | 9D1 | 26 | 27 | | | | | | | | | |
| NUMBOC | -I | 5C0 | 20D0 | 43* | | | | | | | | | |
| OPEN | - | 14F | 18F | | | | | | | | | | |
| PBIV | ()R | 10D1 | 11DA | 32 | | | | | | | | | |
| PFF | ()R | 10D1 | 12DA | 33 | | | | | | | | | |
| PFH | ()R | 10D1 | 13DA | 34 | | | | | | | | | |
| READ | - | 15F | 25F | | | | | | | | | | |
| STOP | - | 26F | 27F | | | | | | | | | | |
| VB | ()R | 8C0 | 35* | 36* | | | | | | | | | |
| 10 | - | 21D0 | 22 | 23 | 39* | | | | | | | | |
| 11 | - | 20D0 | 28 | 38 | 42* | | | | | | | | |
| 15 | - | 40WR | 41* | | | | | | | | | | |
| 100 | - | 15R0 | 16* | | | | | | | | | | |

```
      SUBROUTINE UNSAT
C
C*ABSTRACT: Burial transport model for Shallow Land Burial.
C
C*AUTHOR: CHILDS AND HANKS
C         MODIFICATIONS BY AMIRIJAFARI AND CHENEV AUGUST 1980
C         FURTHER MODS BY L ROBERTSON NOVEMBER 17 , 1980
C
C*TYPE: NUMERICAL ANALYSIS
C
C*CALLED BY:
C         EXEC
C
C*CALLS TO:
C         ADSORB, TMLIST, FIXTIM
C
C*COMMON BLOCKS:
CNAME     HYDRA
C          k, nd, in, numnuc, delw, rain, dry, timwet, timdry,
C          dd, p *e, *w, *timinc, *conq, hdry, hwet, wmtl, wmth, concof,
C          solfac, orient, cumt
CNAME     ADS
C          draw, drns, *kk, totraw, totras, *senter, rncid, *q, rbottm,
C          *qbot, *dec, volwat, wtsoid, raw, ras
CNAME     ATM01
C          *rf
CNAME     HDATA
C          half
CNAME     XDATA
C          iprnt
CNAME     DAQUA
C          *dosex, *tis, *its, *dosee, *tia, *ita
C
C*TECHNICAL DESCRIPTION:
C          Follows nuclides up and down through the soil from where
C          the waste was buried for the amount of time specified by
C          the user.  Nuclides off the top go to ATMOS - DOSET,
C          while off the bottom they go to AQUIFR - DOSET.
C       VARIABLE DESCRIPTIONS:
C          CONQ - Largest water content change allowed each computation.
C          KK - Number of depth boundaries.
C          SENTER - Amount of nuclides entering into that level.
C          Q - Flux at boundary.  + = down, - = up
C          QBOT - Flux at the bottom boundary.
C          DEC - Decay of nuclide.
C          RF - Annual rainfall (meters/year)
C          DOSEX - Nuclides off top (decayed ci/ft**2)
C          DOSEE - Nuclides off bottom (not-decayed ci/ft**2)
C          TIS - Time array for nuclides off the top (hours)
C          TIA - Time array for nuclides off the bottom (hours)
C          ITS - Top time array counter (max=25)
C          ITA - Bottom time array counter (max=10)
C   SOME SUBROUTINE VARIABLES
C          V - Boundary condition array given as flux, time, flux, time, etc.
C          DETT - Time increment to start with and lowest value used.
C          TT - 1. = lansonen (set to this in data statement)
C               0.5 = crank nicholson
C          WFDD - Surface water flow rates
```

```
C            CUMS - Cumulative water flow at the surface
C            H - Water pressure as a function of depth.
C            C - Water pressure for previous time frame.
C
      2       COMMON/HYDRA/ K,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,
             1 DD(60),P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,
             2 CONCOF(60),DNSTY(60),XD(45,60),
             3 SOLFAC(45),ORICNT(45),CUNT,IPASS
      3        COMMON/ADS/ DRAW(45,60),DRAS(45,60),KK,TOTRAW(45),TOTRAS(45),
             1 SENTER(45),RNCLD(45,60),Q(60),RBOTTH(45),QBOT,DEC(45),VOLWAT(60),
             2 WTSOLD(60),RAW(45,60),RAS(45,60)
      4       COMMON/ATMO1/NS,KS,NSS,F1(10,7),FR,RF
      5       COMMON/HDATA/ HALF(45)
      6       COMMON/XDATA/ NAME(45,2),N,ITITLE(12),IPRNT
      7       COMMON/DAQUA/ DOSEX(45,26),TIS(26),ITS,DOSEE(45,11),TIA(11),ITA
      8       COMMON/ALL/ IPATHZ(4),UD,VOL,DI,INTER,NT
      9      DIMENSION IBL(45)
     10       REAL A(60),B(60),C(60),D(52),
             +DURMAT(45),F(60),G(60),
             +H(60),PARTSL(45),
             +RA2TOT(45),
             +RENTER(45),
             +SURMAT(45),T(52),
             +V(600),
             +Y(60),YSOL(45)
     11       DATA IBL/45*1H /
     12       DATA TT,TAA/1.,0./
C
C
C              OPEN FILES HERE...
C-----ZERO OUT ARRAYS
C
     13       IF(IPRNT.EQ.2) WRITE(6,50)
     14    50 FORMAT(1H1,//30X,12HHYDRO OUTPUT,//)
     15       EVAP=0.
     16       CUMS=0.
     17       ITS=0
     18       ITA=0
     19       TIME=0.
     20       CMWATB=0.
     21       SIRF=0.
     22       DO 10 I=1,NUMNUC
     23       RENTER(I)=0.
     24    10 CONTINUE
     25       DO 90 NUC=1,NUMNUC
     26       SURMAT(NUC)=0.
     27       DO 90 LYR=1,60,1
     28    90 RNCLD(NUC,LYR)=0.
     29       NB=K
     30       KK=K+1
     31       DO 150 NUC=1,NUMNUC,1
     32   150 SURMAT(NUC)=ORICNT(NUC)
     33       XTIME=0.
     34       XT=AMAX1(TIMDRY,TIMWET)
     35   172 IER=4*(CUNT/XT+1.)+3
     36       L=IER-3
C     MAXIMUM OF 150 WET/DRY CYLCES FOR TIME CUNT
     37       IF(L.LT.600) GO TO 179
```

```
      IF(INTER.EQ.1) STOP 14
      WRITE(NT,175)
  175 FORMAT(2X,40HTHE TIME IS TOO LONG FOR WET/DRY CYCLES.,/5X,
     1 35HHOW MANY YEARS DO YOU WANT TO RUN ?  )
      READ(NT,*) CUMT
      CUMT=CUMT*24.*365.
      GO TO 172
C
C-----GENERATING LARGE ARRAY OF FLUXES
C
  179 DO 180 I=1,L,4
      V(I)=RAIN
      V(I+1)=TIMWET+XTIME*TIMDRY
      V(I+2)=DRY
      V(I+3)=(XTIME+1.)*TIMDRY
  180 XTIME=XTIME+1.
      IF(IPRNT.NE.2) GO TO 220
      WRITE (6,200)
  200 FORMAT (/,6X,1HK,4X,3HIER,5X,2HND,
     +5X,2HIN,7H NUMNUC)
      WRITE (6,210) K,IER,ND,IN,NUMNUC
  210 FORMAT (1617)
  220 T(1)=0.
      D(1)=(E(1)*(P(2)-P(1)))
      DO 230 I=2,ND,1
      D(I)=E(I)*(P(I)-P(I-1))+D(I-1)
  230 T(I)=DELW+T(I-1)
C
C-----PRINT TABLE OF POTENTIAL, CONDUCTIVITY, AND DIFFUSIVITY
C
      IF(IPRNT.NE.2) GO TO 320
      WRITE (6,240)
  240 FORMAT (/,4X,5HWATER,5X,34HPOTENTIAL CONDUCTIVITY DIFFUSIVITY,
     +16X,5HWATER,5X,34HPOTENTIAL CONDUCTIVITY DIFFUSIVITY)
      NE=ND/2
      DO 250 I=1,NE,1
  250 WRITE (6,260) T(I),P(I),E(I),D(I),T(NE+I),P(NE+I),E(NE+I),D(NE+I)
  260 FORMAT (1P4E12.4,12X,4E12.4)
  320 KC=1
      LL=1
C
      CONCOF(1)=1.
      DO 340 NUC=1,NUMNUC,1
  340 DEC(NUC)=1.
C
C-----CALCULATION OF 'DETT'
C
      IF(V(2).GT.CUMT) V(2)=CUMT
      TIMINC=V(2)/100.
      CONQ=V(1)*0.048/7.680E-4
      IF(CONQ.LT.0.1) CONQ=.1
      DETT=(V(2)-TIME)/TIMINC
      DELT=DETT
      TBB=1.-TAA
      TM=1.-TT
      J=(W(1)-T(1))/DELW+1
      IF(J.LE.0.OR.J.GT.ND) STOP 01
      H(1)=(P(J+1)-P(J))*(W(1)-T(J))/DELW+P(J)
```

```
      83            C(I)=H(I)
      84            C(I)=DELW/(P(J+1)-P(J))
                  C
                  C-----'PIT' IS ORIGINAL WATER IN COLUMN
                  C
      85            PIT=0.
      86            DO 360 I=2,K,1
      87          360 PIT=W(I)*(DD(I+1)-DD(I-1))/2.+PIT
      88            DO 370 I=2,KK,1
      89            J=(W(I)-T(1))/DELW+1.
      90            IF(J.LE.0.OR.J.GT.ND) STOP 02
      91            H(I)=(P(J+1)-P(J))*(W(I)-T(J))/DELW+P(J)
      92            C(I)=DELW/(P(J+1)-P(J))
      93          370 C(I)=H(I)
      94            DO 390 I=1,KK,1
      95          400 FORMAT (1P11E12.4)
      96          390 Y(I)=W(I)
      97            IF(IPRNT.EQ.2) WRITE (6,420)
      98          420 FORMAT (/,4X,8HTIME END,3X,20HSOIL FLUX     ET FLUX)
      99            DO 430 I=2,IER,2
     100            IF(V(I).GT.CUMT) V(I)=CUMT
                  C
                  C-----FLUXES WRITTEN ON OUTPUT
                  C
     101          430 IF(IPRNT.EQ.2) WRITE (6,400) V(I),V(I-1)
                  C
     102            EOR=V(1)
     103            WFDD=V(1)
                  C
                  C
     104            IF(IPRNT.NE.2) GO TO 605
     105            WRITE (6,460)
     106          460 FORMAT (/,5X,4HDETT,8X,4HCONQ,8X,2HTT,9X
                     +,4HCUMT)
     107            WRITE (6,400) DETT,CONQ,TT,CUMT
     108            WRITE (6,470)
     109          470 FORMAT (/,5X,4HHDRY,8X,4HHWET,8X,4HWATL,8X,4HWATH,
                     +9X,4HDELW)
     110            WRITE (6,400) HDRY,HWET,WATL,WATH,DELW
     111            KCK=1
     112           WRITE(6,510)
     113          510 FORMAT (/,4X,43HTHESE ARE THE FLUXES IN EACH LAYER IN ORDER)
     114            WRITE (6,400) (Q(I),I=1,KK),QBOT
                  C
                  C-----COMPUTATION OF CONDUCTIVITY (B) AND WATER CAPACITY (C)
                  C
     115          605  NOWCNT=0
     116            BOT=WATL
     117          610 TOP=WATH
     118            HKP=H(1)
     119            WKP=W(1)
     120            IF (EOR-1.157E-9) 620,640,630
     121          620 W(1)=WATL
     122            H(1)=HDRY
     123            GO TO 640
     124          630 W(1)=WATH
     125            H(1)=HWET
     126          640 TWW=(W(1)+Y(1))*0.5
```

```
      IF (TWW.GT.WATH) TWW=WATH
      J=(TWW-T(1))/DELW+1.
      IF(J.GT.ND.OR.J.LE.0) STOP 03
      BB=(TWW-T(J))/DELW
      DIFFA=(D(J+1)-D(J))*BB+D(J)
      HI=(P(J+1)-P(J))*BB+P(J)
      DO 650 I=1,K,1
      TW=(W(I+1)+Y(I+1))*0.5
      J=(TW-T(1))/DELW+1.
      IF(J.LE.0.OR.J.GT.ND) STOP 04
      BB=(TW-T(J))/DELW
      DIFFB=(D(J+1)-D(J))*BB+D(J)
      CI=(P(J+1)-P(J))*BB+P(J)
      IF (ABS(EOR).GT.1E-9) GO TO 660
      B(I)=0.
      GO TO 750
  660 IF (ABS(HI-CI).LT.1E-4) GO TO 740
      B(I)=(DIFFA-DIFFB)/(HI-CI)*CONCOF(I)
      IF (I.GT.1) GO TO 750
  670 ER=(B(1)*(H(1)*TT-H(2)*TT-G(2)*TH+G(1)*TH+DD(2)))/DD(2)
      IF ((ABS(1.1*EOR-ER)-ABS(0.1*EOR)).LE.0.) GO TO 680
      IF (KCK.EQ.1) GO TO 690
      IF (KCK.LT.10) GO TO 700
  680 H(1)=(EOR*DD(2)/B(1)+H(2)*TT-G(1)*TH+G(2)*TH-DD(2))/TT
      IF (H(1).LT.HDRY) H(1)=HDRY
      IF (H(1).GT.HWET) H(1)=HWET
      GO TO 750
  690  H(1)=HKP
      W(1)=WKP
      KCK=KCK+1
      GO TO 640
  700 KCK=KCK+1
      IF (ER-EOR) 710,750,720
  710 IF ((W(1)-WATH).GE.0.) GO TO 750
      BOT=W(1)
      W(1)=(W(1)+TOP)*0.5
      GO TO 730
  720 IF ((W(1)-WATL).LE.0.) GO TO 750
      TOP=W(1)
      W(1)=(W(1)+BOT)*0.5
  730  J=(W(1)-T(1))/DELW+1.
      IF(J.LE.0.OR.J.GT.ND) STOP 05
      BB=(W(1)-T(J))/DELW
      IF (ABS(EOR-0.).LT.1E-9) GO TO 750
      H(1)=(P(J+1)-P(J))*BB+P(J)
      TWW=(W(1)+Y(1))*0.5
      J=(TWW-T(1))/DELW+1.
      IF(J.LE.0.OR.J.GT.ND) STOP 06
      BB=(TWW-T(J))/DELW
      DIFFA=(D(J+1)-D(J))*BB+D(J)
      HI=(P(J+1)-P(J))*BB+P(J)
      GO TO 660
  740 B(I)=(D(J+1)-D(J))*CONCOF(I)/(P(J+1)-P(J))
      IF (I.EQ.1) GO TO 670
  750 TWW=TW
      HI=CI
      DIFFA=DIFFB
      TW=(W(I+1)+Y(I+1))*0.5
```

```
      J=(TW-T(1))/DELW+1.
      IF(J.LE.0.OR.J.GT.ND) STOP 07
  650 C(I+1)=DELW/(P(J+1)-P(J))
      B(KK)=B(K)
      KCK=1
C
C-----NEW T-POT WHEN E-ACTUAL IS LESS THAN E-POT
C
      DO 770 I=2,K,1
  770 A(I)=0.
C
C-----WATER FLOW TRIDIAGONAL MATRIX SOLN SOLVES DARCY'S FLOW EQN FOR H
C
  780 DO 790 I=2,K,1
      POT=(DD(I+1)-DD(I-1))/(2.*DELT)
      DLXA=(DD(I)-DD(I-1))
      DLXB=(DD(I+1)-DD(I))
      BB=C(I)*POT/TT+B(I)/DLXB+B(I-1)/DLXA
      DA=(C(I)*POT*C(I)+(B(I)/DLXB)*(TH*(C(I+1)-C(I))-DLXB)+(B(I-1)/DLXA
     +)*(TH*(C(I-1)-C(I))+DLXA)+A(I)*(DD(I+1)-DD(I-1))*0.5)/TT
      IF (I.GT.2.) GO TO 820
      IF (H(1).GE.HWET.OR.H(1).LE.HDRY) GO TO 800
      DA=DA-((B(I-1)/DLXA)*(TH*(C(I-1)-C(I))+DLXA))/TT+EOR/TT
      BB=BB-B(I-1)/DLXA
      GO TO 810
  800 DA=DA+H(I-1)*B(I-1)/DLXA
  810 F(I)=DA/BB
      E(I)=(B(I)/DLXB)/BB
      GO TO 790
  820 IF (I.GE.K) GO TO 830
      E(I)=(B(I)/DLXB)/(BB-(B(I-1)/DLXA)*E(I-1))
      F(I)=(DA+(B(I-1)/DLXA)*F(I-1))/(BB-(B(I-1)/DLXA)*E(I-1))
  790 CONTINUE
  830 BB=BB-TAA*B(I)/DLXB
      DA=DA+TAA*(B(I)/DLXB)*((C(I)-C(I+1))*TH+DLXB)/TT+TBB*B(I)/
     +DLXB*H(KK)
      H(I)=(DA+(B(I-1)/DLXA)*F(I-1))/(BB-(B(I-1)/DLXA)*E(I-1))
  840 I=I-1
      H(I)=E(I)*H(I+1)+F(I)
      IF (I.GT.2) GO TO 840
      DO 860 I=2,KK,1
      IF (H(I)-DD(I)-HWET.LE.0.) GO TO 860
      H(I)=HWET+DD(I)
  860 CONTINUE
C
C-----FLUXES CALCULATED FROM H'S
C
      Q(1)=DELT*EOR
      DO 870 J=2,K,1
      BB=H(J-1)-H(J)
      DDD=DD(J)-DD(J-1)
      AVEC=(B(J-1)+B(J))/2.
  870 Q(J)=DELT*BB/DDD*AVEC
C
C-----COMPUTATION OF WATER CONTENTS AS A FUNCTION OF PRESSURES
C
      IF (H(1).GE.HWET.OR.H(1).LE.HDRY) GO TO 880
      WFDD=EOR
```

```
      IF (ABS(EOR).GT.1E-9) GO TO 910
      H(1)=H(2)
      GO TO 930
  880 WFDD=B(1)*((H(1)-H(2))*TT+(G(1)-G(2))*TM+DD(2))/DD(2)
      IF (ABS(WFDD).LT.ABS(EOR)) GO TO 930
      WFDD=EOR
      IF (B(1).LT.4.364E-7) B(1)=4.364E-7
      H(1)=(EOR*DD(2)/B(1)+H(2)*TT-G(1)*TM+G(2)*TM-DD(2))/TT
      GO TO 930
  910 IF(B(1).LT.(4.364E-7)) B(1)=4.364E-7
      H(1)=(EOR*DD(2)/B(1)+H(2)*TT-G(1)*TM+G(2)*TM-DD(2))/TT
      IF(H(1).LT.HDRY) H(1)=HDRY
      IF(H(1).GT.HWET) H(1)=HWET
      GO TO 880
  930 I=1
      IF (ABS(H(I)-G(I)).LT.1E-4) GO TO 990
      NHI=ND
      NLO=1
      J=25
  940 IF (H(I)-P(J)) 950,980,960
  950 NHI=J
      GO TO 970
  960 NLO=J
  970 JT=J
      J=(NHI-NLO)/2+NLO
      IF(J.LE.0.OR.J.GT.ND) STOP 10
      IF ((ABS(J-JT).GT.0.) GO TO 940
      IF (H(I).GE.P(J)) GO TO 980
      J=J-1
      IF(J.LE.0) J=1
  980 WAT=(H(I)-P(J))*DELW/(P(J+1)-P(J))+T(J)
      W(I)=WAT
      GO TO 1000
  990 W(I)=Y(I)
 1000 DO 1010 I=1,KK,1
      W(I)=C(I)*(H(I)-G(I))+Y(I)
      IF (W(I).GT.WATH) W(I)=WATH
      IF (W(I).LT.WATL) W(I)=WATL
 1010 CONTINUE
      W(KK)=WATH
      IF(V(KC+1)-TIME.GE.DELT) GO TO 1015
      DELT=V(KC+1)-TIME
      GO TO 780
C
C-----TEST WATER SAT CHG; IF CHG (SUM3) IS TOO LARGE, DECREASE 'DELT'
C
C
 1015 SUM1=0
      SUM2=0
      SUM3=0
      DO 1020 I=2,K,1
      SUM1=SUM1+W(I)
      SUM2=SUM2+Y(I)
      IF (ABS(SUM1-SUM2).LE.ABS(SUM3)) GO TO 1020
      SUM3=SUM1-SUM2
 1020 CONTINUE
      IF (ABS(SUM3).LE.ABS(CONQ)) GO TO 1030
      IF (DELT.LE.DETT*0.001) GO TO 1030
```

```
      283            DELT=0.25*DELT
      284            GO TO 700
                  C
      285       1030 SUM1=0.
      286            SUM2=0.
                  C
      287            DO 1050 I=2,K,1
      288            SUM1=W(I)*(DD(I+1)-DD(I-1))/2.+SUM1
      289       1050 SUM2=Y(I)*(DD(I+1)-DD(I-1))/2.+SUM2
      290            WFUU=B(NB)*((H(NB)-H(NB+1))*TT+(G(NB)-G(NB+1))*TM+DD(NB+1)-DD(NB))
                    1 /(DD(NB+1)-DD(NB))
      291            QBOT=WFUU*DELT
      292            Q(KK)=QBOT
                  C
                  C-----CALCULATE PARTIAL FRACTIONAL NUCLIDE SOLUBILITIES
                  C
      293            TSOL=0.
      294            DO 1060 NUC=1,NUMNUC,1
      295            IF (SURMAT(NUC).GT.0.) TSOL=TSOL+SOLFAC(NUC)
      296       1060 CONTINUE
      297            DO 1070 NUC=1,NUMNUC,1
      298            IF (SURMAT(NUC).GT.0.) GO TO 1080
      299            GO TO 1070
      300       1080 YSOL(NUC)=SOLFAC(NUC)/TSOL
      301            PARTSL(NUC)=YSOL(NUC)*SOLFAC(NUC)
      302       1070 CONTINUE
      303            CUMS=Q(1)+CUMS
      304            IF(Q(1).GT.0.) SIRF=Q(1)+SIRF
      305            IF(Q(1).LT.0.) EVAP=Q(1)+EVAP
      306            CMWATB=WFUU*DELT+CMWATB
      307            BALANC=CUMS-CMWATB+PIT-SUMI
      308            DELTSV=DELT
      309            DETTSV=DETT
                  C
                  C-----SIMPLE RADIODECAY CODE
                  C
      310            DO 1088 NUC=1,NUMNUC,1
      311            RPOWER=TIME*HALF(NUC)/(365.*24.*.693)
      312            IF (RPOWER.GT.20.) GO TO 1089
      313            DEC(NUC)=2.**(-(RPOWER))
      314            GO TO 1088
      315       1089 DEC(NUC)=0.
      316       1088 CONTINUE
                  C
                  C-----INJECTION OF NUCLIDES INTO LAYER 'IN'
                  C
      317            DO 1090 NUC=1,NUMNUC,1
      318            SOL=PARTSL(NUC)
      319            IF (SURMAT(NUC).LE.0.) SOL=0.
      320            SENTER(NUC)=SOL*W(IN)*(DD(IN+1)-DD(IN-1))/2.-RAW(NUC,IN)
      321            IF (SENTER(NUC).LT.0.) SENTER(NUC)=0.
      322            IF (SENTER(NUC).GT.SURMAT(NUC)) SENTER(NUC)=SURMAT(NUC)
      323            RENTER(NUC)=SENTER(NUC)+RENTER(NUC)
      324       1090 SURMAT(NUC)=SURMAT(NUC)-SENTER(NUC)
                  C
                  C-----CALL ADSORPTION/PASSAGE S/R 'ADSORB'
                  C
      325            CALL ADSORB
```

```
      IF (EOR.LE.0) GO TO 1100
 1100 TIME=TIME+DELT
      ITS=ITS+1
      IT=ITS
      TIS(IT)=TIME
      IF(IT.GT.25) CALL FIXTIM(IT)
       ITA=ITA+1
      IT=ITA
      TIA(IT)=TIME
      IF(IT.GT.10) CALL FIXTIM(IT)
      TIS(ITS)=TIME
      TIA(ITA)=TIME
      DO 1110 I=1,NUMNUC
C  RBOTTM IS CURIES UNDECAYED
      DOSEE(I,ITA)=RBOTTM(I)
C  RIGHT NOW DOSEE IS CURIES/FT**2 WILL CONVERT TO CURIES/FT**3 IN EXEC
      DOSEX(I,ITS)=RAS(I,1)*DEC(I)
 1110 CONTINUE
      NOWCNT=NOWCNT+1
      IF (ABS(SUM3-0.).GT.1E-4) GO TO 1140
 1130 DELT=1.5*DELT
      GO TO 1170
 1140 TW=ABS(CONQ*DELT/SUM3)
      IF (TW.GE.0.1*DETT) GO TO 1150
      TW=0.1*DETT
      GO TO 1160
 1150 IF (TW.LE.1E3*DETT) GO TO 1160
      TW=DETT*1E3
 1160 IF (TW.GT.2.*DELT) GO TO 1130
      DELT=TW
 1170 IF (NDLTNM.GT.0) GO TO 1220
      NDLTNM=NDLTNM+1
      IF(IPRNT.NE.2) GO TO 1220
      WRITE(6,1180) TIME
 1180 FORMAT(1H1,/,4X,7HTIME IS ,E11.4)
      WRITE(6,1190)
 1190 FORMAT (/,6X,2HDD,8X,6HWTSOLD,6X,6HVOLWAT,6X,5HRNCLD,8X,3HRAW,
     +9X,3HRAS,10X,1HW,11X,1HB,11X,1HH,11X,1HQ)
      WRITE(6,1195)
 1195 FORMAT(5X,4H(FT),9X,2HGM,10X,2HML,10X,2HCI,10X,2HCI,10X,2HCI)
      DO 1200 LYR=1,KK,1
      TRAS=0.
      TRAW=0.
      TRNCLD=0.
      DO 1210 NUC=1,NUMNUC,1
      TRAS=TRAS+DRAS(NUC,LYR)
      TRAW=TRAW+DRAW(NUC,LYR)
 1210 TRNCLD=TRNCLD+RNCLD(NUC,LYR)
 1200 WRITE (6,400) DD(LYR),WTSOLD(LYR),VOLWAT(LYR),TRNCLD,TRAW,TRAS,
     +W(LYR),B(LYR),H(LYR),Q(LYR)
 1220 IF (DELT.LT.0.5*DETT) DELT=0.5*DETT
      IF (DELT.GT.5.*DETT) DELT=5.*DETT
      IF(TIME.GE.CUMT) GO TO 1230
      IF (ABS(TIME-V(KC+1)).GT.0.01*DETT) GO TO 1300
 1230 CONTINUE
      Q1=Q(1)
      IF(IPRNT.NE.2) GO TO 1310
      CALL THLIST (TIME,DETTSV,DELTSV,Q1,WFDD,SIRF,SUM1,EVAP,PIT,
```

```
     1 BALANC,CMWATR,CUMS)
C
C-----PRINT TTL NUCLIDES, WATER SAT, CONDUCTIVITY, HEAD, AND FLUX
C
      WRITE (6,1190)
      WRITE(6,1195)
      DO 1240 LYR=1,KK,1
      TRAS=0.
      TRAW=0.
      TRNCLD=0.
      DO 1245 NUC=1,NUMNUC,1
      TRNCLD=TRNCLD+RNCLD(NUC,LYR)*DEC(NUC)
      TRAW=TRAW+DRAW(NUC,LYR)
 1245 TRAS=TRAS+DRAS(NUC,LYR)
 1240 WRITE (6,400) DD(LYR),WTSOLD(LYR),VOLWAT(LYR),TRNCLD,TRAW,
     +TRAS,W(LYR),B(LYR),H(LYR),Q(LYR)
C
C-----PRINT NUCLIDE HALFLIFE, ORIGINAL AMT, SOLUBILITY, AND ADSORPTION
C
      DO 1250 NUC=1,NUMNUC,1
      RA2TOT(NUC)=TOTRAW(NUC)+TOTRAS(NUC)
 1250 DURMAT(NUC)=SURMAT(NUC)*DEC(NUC)
      WRITE (6,1260)
 1260 FORMAT (/,2X,7HNUCLIDE,8X,4HHALF,7X,5HDECAY,6X,8HORIGINAL,3X,
     +9HREMAINING,5X,7HENTERED,3X,9HAMOUNT IN,3X,10HAMOUNT OFF,2X,
     +10HSOLUBILITY,2X,9HKD BASALT)
      WRITE (6,1270)
 1270 FORMAT (3X,4HNAME,10X,4HLIFE,7X,6HFACTOR,6X,6HAMOUNT,4X,
     +10HON SURFACE,2X,10HCOL-NO DEC,3X,6HCOLUMN,6X,6HBOTTOM)
      DO 1280 NUC=1,NUMNUC,1
      HAFLIF=365.*24.*.693/HALF(NUC)
 1280 WRITE(6,1290)(NAME(NUC,J),J=1,2),HAFLIF,DEC(NUC),ORICNT(NUC),
     +DURMAT(NUC),RENTER(NUC),RA2TOT(NUC),RBOTTM(NUC),SOLFAC(NUC),
     +XD(NUC,IN+1)
 1290 FORMAT (2X,2A3,4X,1P9E12.4)
      ITAB=1
      IF(NUMNUC.GT.10) ITAB=2
      IF (NUMNUC.GE.20) ITAB=3
      DO 1300 NTAB=1,ITAB,1
      NEND=10*NTAB
      NST=NEND-9
      IF (NEND.GT.NUMNUC) NEND=NUMNUC
      WRITE (6,1083) ((NAME(NUC,J),J=1,2),NUC=NST,NEND)
 1083 FORMAT(//,6X,2HDD,2X,10(6X,2A3))
      WRITE(6,1084) (IBL(NUC),NUC=NST,NEND)
 1084 FORMAT(5X,4H(FT),1X,10(5X,A1,6HMC1/CM))
      DO 1320 LYR=1,KK
      DO 1330 NUC=NST,NEND,1
      RA2TOT(NUC)=RNCLD(NUC,LYR)*DEC(NUC)*1E6/(WTSOLD(LYR)+VOLWAT(LYR))
      IF(RA2TOT(NUC).LT.1.E-30) RA2TOT(NUC)=0.0
 1330 CONTINUE
      DO 1340 NUC=NST,NEND,1
      IF (RA2TOT(NUC).GT.0.0) GO TO 1350
 1340 CONTINUE
      GO TO 1320
 1350 WRITE (6,400) DD(LYR),(RA2TOT(NUM),NUM=NST,NEND)
 1320 CONTINUE
 1300 CONTINUE
```

```
      1310 IF(TIME.GE.CUMT) GO TO 1520
           NOWCNT=0
           EOR=V(KC+2)
           KC=KC+2
           DETT=(V(KC+1)-V(KC-1))/TIMINC
           DELT=DETT
           GO TO 1390
      1380 IF ((TIME+DELT).LE.V(KC+1).AND.(TIME.LE.V(KC+1)) GO TO 1390
           DELT=V(KC+1)-TIME
           IF (DELT.LE.0.) GO TO 1230
      1390 LL=LL+1
           IF (DELT.LT.DETT) DELT=DETT
           Y(1)=(W(1)+Y(1))*0.5
           J=(Y(1)-T(1))/DELW+1
           IF(J.LE.0.OR.J.GT.ND) STOP 12
           BB=(Y(1)-T(J))/DELW
           IF (ABS(EOR-0.).LT.1E-4) GO TO 1470
           C(1)=(P(J+1)-P(J))*BB+P(J)
      1470 DO 1480 I=2,KK,1
           J=(W(I)-T(I))/DELW+1
           IF(J.LE.0.OR.J.GT.ND) STOP 13
           BB=(W(I)-T(J))/DELW
           C(I)=(P(J+1)-P(J))*BB+P(J)
           TW=(W(I)-Y(I))+W(I)
           IF (TW.GT.WATH) GO TO 1490
           IF (TW.GE.WATL) GO TO 1500
           TW=WATL
           GO TO 1500
      1490 TW=WATH
      1500 Y(I)=W(I)
      1480 W(I)=TW
           IF(TIME.GE.CUMT) GO TO 1520
           GO TO 610
      1520 CONTINUE
C  AMOUNT OF RAIN METERS/YEAR CONVERTED FROM ACCUMULATED INCHES
           RF=SIRF*24.*365.2*.0254/TIME
           RETURN
           END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADS | - | 4CN | DAQUA | - | 7CN | FR | -R | 4CO | IPATHZ( ) I | 8CO | NSS | -I | 4CO | UD | -R | 8CO | |
| ADSORB | - | 325SU | DI | -R | 8CO | HDATA | - | 5CN | ITITLE( ) I | 6CO | READ | - | 41F | UNSAT | - | 1SU | |
| ALL | - | 8CN | DIMENS | - | 9F | HYDRA | - | 2CN | KS | -I | 4CO | REAL | - | 10F | VOL | -R | 8CO | |
| AMAX1 | - | 94SU | DRSTY ( )R | | 2CO | IABS | - | 255SU | N | -I | 6CO | RETURN | - | 460F | XDATA | - | 6CN | |
| ATM01 | - | 4CN | FI | ( )R | 4CO | IPASS | -I | 2CO | NS | -I | 4CO | THLIST | - | 379SU | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | ( )R | 10RL | 191= | 197 | | | | | | | | | | | | | |
| ABS | - | 140SU | 143SU | 147SU | 147SU | 170SU | 229SU | 233SU | 233SU | 244SU | 270SU | 276SU | 281SU | 281SU | 343SU | 346SU | 376SU | 441SU |
| AVEC | -R | 226= | 226 | | | | | | | | | | | | | | |
| B | ( )R | 10RL | 141= | 144= | 146 | 150 | 179= | 188= | 188 | 196 | 196 | 197 | 197 | 200 | 201 | 203 | 203 | 208 |
| | | 208 | 209 | 209 | 211 | 212 | 212 | 213 | 213 | 226 | 226 | 232 | 235 | 236= | 236 | 238 | 238= | 239 |
| | | 290 | 371WR | 390WR | | | | | | | | | | | | | | |
| BALANC | -R | 307= | 379AC | | | | | | | | | | | | | | | |
| BB | -R | 130= | 131 | 132 | 137= | 138 | 139 | 169= | 171 | 176= | 176 | 177 | 196= | 201= | 201 | 204 | 205 | 208 |
| | | 209 | 211= | 211 | 243 | 440= | 442 | 446= | 447 | | | | | | | | | |
| BOT | -R | 116= | 161= | 166 | | | | | | | | | | | | | | |
| C | ( )R | 10RL | 84= | 92= | 187= | 196 | 197 | 264 | | | | | | | | | | |
| CALL | - | 325F | 331F | 335F | 379F | | | | | | | | | | | | | |
| CNVATB | -R | 20= | 306= | 306 | 307 | 379AC | | | | | | | | | | | | |
| COMMON | - | 2F | 3F | 4F | 5F | 6F | 7F | 8F | | | | | | | | | | |
| CONCOF | ( )R | 2CO | 69= | 144 | 179 | | | | | | | | | | | | | |
| CONQ | -R | 2CO | 74= | 75 | 75= | 107WR | 201 | 346 | | | | | | | | | | |
| CONS | -R | 16= | 303= | 303 | 307 | 379AC | | | | | | | | | | | | |
| CUMT | -R | 2CO | 35 | 41RD | 42= | 42 | 72 | 72 | 100 | 100 | 107WR | 374 | 425 | 456 | | | | |
| D | ( )R | 10RL | 56= | 58= | 58 | 65WR | 65WR | 131 | 131 | 131 | 138 | 138= | 138 | 176 | 176 | 176 | 179 | 179 |
| DA | -R | 197= | 200= | 200 | 203= | 203 | 204 | 209 | 212= | 212 | 213 | | | | | | | |
| DATA | - | 11F | 12F | | | | | | | | | | | | | | | |
| DD | ( )R | 2CO | 87 | 87 | 146 | 146 | 150 | 150 | 193 | 193 | 194 | 194 | 195 | 195 | 197 | 197 | 210 | 219 |
| | | 224 | 224 | 232 | 232 | 236 | 236 | 239 | 239 | 288 | 288 | 289 | 289 | 290 | 290 | 290 | 290 | 320 |
| | | 320 | 371WR | 390WR | 422WR | | | | | | | | | | | | | |
| DDD | -R | 224= | 226 | | | | | | | | | | | | | | | |
| DEC | ( )R | 3CO | 71= | 313= | 315= | 340 | 387 | 393 | 400WR | 415 | | | | | | | | |
| DELT | -R | 77= | 193 | 221 | 226 | 269 | 270= | 282 | 283= | 283 | 291 | 306 | 308 | 327 | 344= | 344 | 346 | 362 |
| | | 363= | 372 | 372= | 373 | 373= | 430= | 432 | 433= | 434 | 436 | 436= | | | | | | |
| DELTSV | -R | 308= | 379AC | | | | | | | | | | | | | | | |
| DELW | -R | 2CO | 59 | 80 | 82 | 84 | 89 | 91 | 92 | 110WR | 128 | 130 | 135 | 137 | 167 | 169 | 173 | 175 |
| | | 185 | 187 | 259 | 430 | 440 | 444 | 446 | | | | | | | | | | |
| DETT | -R | 76= | 77 | 107WR | 282 | 309 | 347 | 348 | 350 | 351 | 372 | 372 | 373 | 373 | 373 | 429= | 430 | 436 |
| | | 436 | | | | | | | | | | | | | | | | |
| DETTSV | -R | 309= | 379AC | | | | | | | | | | | | | | | |
| DH | -R | 223= | 226 | | | | | | | | | | | | | | | |
| DIFFA | -R | 131= | 144 | 176= | 183= | | | | | | | | | | | | | |
| DIFFB | -R | 130= | 144 | 183 | | | | | | | | | | | | | | |
| DLXA | -R | 194= | 196 | 197 | 197 | 200 | 200 | 201 | 203 | 208 | 209 | 209 | 213 | 213 | | | | |
| DLXB | -R | 195= | 196 | 197 | 197 | 205 | 208 | 211 | 212 | 212 | 212 | | | | | | | |
| DOSEE | ( )R | 7CO | 339= | | | | | | | | | | | | | | | |
| DOSEX | ( )R | 7CO | 340= | | | | | | | | | | | | | | | |
| DRAS | ( )R | 3CO | 368 | 389 | | | | | | | | | | | | | | |
| DRAW | ( )R | 3CO | 369 | 388 | | | | | | | | | | | | | | |
| DRY | -R | 2CO | 47 | | | | | | | | | | | | | | | |
| DURMAT | ( )R | 10RL | 393= | 400WR | | | | | | | | | | | | | | |
| E | ( )R | 2CO | 56 | 58 | 65WR | 65WR | 205= | 208= | 208 | 209 | 213 | 215 | | | | | | |
| EOR | -R | 102= | 120 | 140 | 147 | 147 | 150 | 159 | 170 | 200 | 221 | 228 | 229 | 233 | 234 | 236 | 239 | 326 |
| | | 427= | 441 | | | | | | | | | | | | | | | |
| ER | -R | 146= | 147 | 159 | | | | | | | | | | | | | | |
| EVAP | -R | 15= | 305= | 305 | 379AC | | | | | | | | | | | | | |

F ()R 10RL 204= 209= 239 213 215
FIXTIM - 331SU 336SU
G ()R 10RL 83= 93= 146 146 150 150 197 197 197 197 197 200 200 212 212 232
232 236 236 239 239 244 264 290 290 442= 447=
GI -R 139= 143 144 182
H ()R 10RL 82= 83 91= 93 118 122= 125= 146 146 150= 150 151 151= 152 152= 154=
171= 199 199 203 212 213= 215= 215 218 219= 223 223 227 227 230= 230 232
232 236= 236 239= 239 240 240= 241 241= 244 248 256 259 264 290 290 371WR
390WR
HAFLIF -R 399= 400WR
HALF ()R 5C0 311 399
HDRY -R 2C0 110WR 122 151 151 199 227 240 240
HI -R 132= 143 144 177= 182=
HKP -R 143= 154
HWET -R 2C0 110WR 125 152 152 199 218 219 227 241 241
I -I 2200 23 44D0 45 46 47 48 57D0 58 58 58 58 58 59 59 64D0 65WR
65WR 65WR 65WR 65WR 65WR 65WR 65WR 86D0 87 87 87 88D0 89 91 91 92 93
93 94D0 96 96 99D0 100 100 101WR 101WR 114WR 114WR 133D0 134 134 144 144 145
179 179 180 184 184 187 190D0 191 192D0 193 193 194 194 195 195 196 196
196 197 197 197 197 197 197 197 197 197 197 197 198 200 200 200 201
203 203 204 205 205 207 208 208 208 208 209 209 209 209 209 211 213
212 212 212 213 215 213 213 213 214= 214 215 215 215 215 216 217D0 218
218 219 219 243= 244 244 248 256 259 260 262 262 263D0 264 264 264 364
264 265 265 266 266 275D0 276 277 287D0 288 288 288 289 289 289 338D0 339
339 340 340 340 443D0 444 446 447 448 448 448 454 454 455
IBL ()I 9D1 11DA 411WR
IER -I 35= 36 53WR 99D0
IF - 13F 37F 38F 50F 60F 72F 75F 81F 90F 97F 100F 101F 104F 120F 127F 129F 136F
140F 143F 145F 147F 148F 149F 151F 152F 159F 160F 164F 168F 170F 174F 180F 186F 190F
199F 207F 216F 218F 227F 229F 233F 235F 238F 240F 241F 244F 248F 254F 255F 256F 258F
265F 266F 269F 270F 281F 282F 295F 298F 304F 305F 312F 319F 321F 322F 326F 331F 335F
343F 347F 350F 352F 354F 356F 372F 373F 374F 375F 378F 403F 404F 408F 416F 419F 423F
432F 434F 436F 439F 441F 445F 449F 450F 456F
IN -I 2C0 53WR 320 320 320 320 400WR
INTER -I 8C0 38
IPRNT -I 6C0 13 50 60 97 101 104 356 378
IT -I 329= 330 331 331AC 333= 334 335 335AC
ITA -I 7C0 18= 332= 332 333 337 339
ITAB -I 402= 403= 404= 405D0
ITS -I 7C0 17= 328= 328 329 336 340
J -I 80= 81 81 82 82 82 82 84 84 89= 90 90 91 91 91 91 92
92 128= 129 129 130 131 131 131 132 132 132 135= 136 136 137 138 138
138 139 139 139 167= 168 168 169 171 171 171 173= 174 174 175 176 176
176 177 177 177 179 179 179 179 185= 186 186 187 187 222D0 223 223 224
224 225 225 226 247= 248 249 251 252 253= 254 254 255 256 257= 257 258
258= 259 259 259 259 400WR 400WR 409WR 409WR 438= 439 439 440 442 442 442 444=
445 445 446 447 447 447
JT -I 252= 255
K -I 2C0 29 30 53WR 86D0 133D0 188 190D0 192D0 207 222D0 275D0 287D0
KC -I 67= 269 270 375 427 428= 428 429 429 432 432 433
KCK -I 111= 148 149 156= 156 158= 158 189=
KK -I 9C0 30= 88D0 94D0 114WR 188 212 217D0 263D0 268 292 363D0 382D0 413D0 443D0
L -I 36= 37 44D0
LL -I 68= 435= 435
LYR -I 27D0 28 363D0 368 369 370 371WR 371WR 371WR 371WR 371WR 371WR 371WR 382D0 387 388 389
390WR 390WR 390WR 390WR 390WR 390WR 413D0 415 415 422WR
NAME ()I 6C0 400WR 409WR
NB -I 29= 290 290 290 290 290 290 290 290 290

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ND | -I | 2C0 | 53WR | 57D0 | 63 | 81 | 90 | 129 | 136 | 168 | 174 | 186 | 245 | 254 | 439 | 445 | |
| NDLTN.I | -I | 354 | 355= | 353 | | | | | | | | | | | | | |
| NE | -I | 63= | 64D0 | 65WR | 65WR | 65WR | 65WR | | | | | | | | | | |
| NEND | -I | 406= | 407 | 408 | 408= | 409WR | 411WR | 414D0 | 418D0 | 422WR | | | | | | | |
| NH1 | -I | 248= | 249= | 253 | | | | | | | | | | | | | |
| NLO | -I | 246= | 251= | 253 | 253 | | | | | | | | | | | | |
| NOWCNT | -I | 115= | 342= | 342 | 426= | | | | | | | | | | | | |
| NST | -I | 407= | 409WR | 411WR | 414D0 | 418D0= | 422WR | | | | | | | | | | |
| NT | -I | 8C0 | 39WR | 41RD | | | | | | | | | | | | | |
| NTAB | -I | 405D0 | 406 | | | | | | | | | | | | | | |
| NUC | -I | 25D0 | 26 | 28 | 31D0 | 52 | 32 | 70D0 | 71 | 294D0 | 295 | 296 | 297D0 | 298 | 300 | 300 | 301 | 301 |
| | | 301 | 310D0 | 311 | 313 | 315 | 317D0 | 318 | 319 | 320 | 320 | 321 | 321 | 322 | 322 | 322 | 322 | 323 |
| | | 323 | 323 | 324 | 324 | 324 | 367D0 | 368 | 369 | 370 | 386D0 | 387 | 387 | 388 | 389 | 391D0 | 392 | 392 |
| | | 392 | 393 | 393 | 393 | 398D0. | 399 | 400WR | 400WR | 400WR | 400WR | 400WR | 400WR | 400WR | 400WR | 400WR | 409WR | 409WR |
| | | 411WR | 411WR | 414D0 | 415 | 415 | 415 | 416 | 416 | 418D0 | 419 | | | | | | | |
| NUM | -I | 422WR | 422WR | | | | | | | | | | | | | | | |
| NUMNUC | -I | 2C0 | 22D0 | 25D0 | 31D0 | 53WR | 70D0 | 294D0 | 297D0 | 310D0 | 317D0 | 338D0 | 367D0 | 386D0 | 391D0 | 398D0 | 403 | 404 |
| | | 406 | 406 | | | | | | | | | | | | | | | |
| ORIENT | ()R | 2C0 | 32 | 400WR | | | | | | | | | | | | | | |
| P | ()R | 2C0 | 56 | 56 | 58 | 58 | 65WR | 65WR | 82 | 82 | 82 | 84 | 84 | 91 | 91 | 91 | 92 | 93 |
| | | 132 | 132 | 132 | 139 | 139 | 139 | 171 | 171 | 171 | 177 | 177 | 177 | 179 | 179 | 187 | 187 | 348 |
| | | 256 | 259 | 259 | 259 | 442 | 442 | 442 | 447 | 447 | 447 | | | | | | | |
| PARTSL | ()R | 10RL | 301= | 318 | | | | | | | | | | | | | | |
| PIT | -R | 85= | 87= | 87 | 367 | 379AC | | | | | | | | | | | | |
| POT | -R | 193= | 196 | 197 | | | | | | | | | | | | | | |
| Q | ()R | 3C0 | 114WR | 221= | 226= | 292= | 303 | 304 | 304 | 305 | 305 | 371WR | 377 | 390WR | | | | |
| QI | -R | 377= | 379AC | | | | | | | | | | | | | | | |
| QUOT | -R | 3C0 | 114WR | 291= | 292 | | | | | | | | | | | | | |
| RAITOT | ()R | 10RL | 392= | 400WR | 415= | 416 | 416= | 419 | 422WR | | | | | | | | | |
| RAIN | -R | 2C0 | 45 | | | | | | | | | | | | | | | |
| RAS | ()R | 3C0 | 340 | | | | | | | | | | | | | | | |
| RAW | ()R | 3C0 | 320 | | | | | | | | | | | | | | | |
| RBOTTM | ()R | 3C0 | 339 | 400WR | | | | | | | | | | | | | | |
| RENTER | ()R | 10RL | 23= | 323= | 323 | 400WR | | | | | | | | | | | | |
| RF | -R | 4C0 | 459= | | | | | | | | | | | | | | | |
| RNCLD | ()R | 3C0 | 28= | 370 | 367 | 415 | | | | | | | | | | | | |
| RPOWER | -R | 311= | 312 | 313 | | | | | | | | | | | | | | |
| SENTER | ()R | 3C0 | 320= | 321 | 321= | 322 | 322= | 323 | 324 | | | | | | | | | |
| SIRF | -R | 21= | 304= | 304 | 379AC | 459 | | | | | | | | | | | | |
| SOL | -R | 318= | 319= | 320 | | | | | | | | | | | | | | |
| SOLFAC | ()R | 2C0 | 295 | 300 | 301 | 400WR | | | | | | | | | | | | |
| STOP | - | 30F | 81F | 90F | 129F | 136F | 160F | 174F | 186F | 254F | 439F | 445F | | | | | | |
| SUBI | -R | 272= | 276= | 276 | 278 | 279 | 285= | 288= | 288 | 307 | 379AC | | | | | | | |
| SUB2 | -R | 273= | 277= | 277 | 278 | 279 | 286= | 289= | 289 | | | | | | | | | |
| SUB3 | -R | 274= | 278 | 279= | 281 | 343 | 346 | | | | | | | | | | | |
| SURMAT | ()R | 10RL | 26= | 32= | 295 | 298 | 319 | 322 | 322 | 324= | 324 | 393 | | | | | | |
| T | ()R | 10RL | 55= | 59= | 59 | 65WR | 65WR | 80 | 82 | 89 | 91 | 128 | 130 | 136 | 137 | 167 | 169 | 178 |
| | | 178 | 185 | 359 | 438 | 440 | 444 | 446 | | | | | | | | | | |
| TAA | -R | 12DA | 78 | 211 | 212 | | | | | | | | | | | | | |
| TBB | -R | 78= | 212 | | | | | | | | | | | | | | | |
| TIA | ()R | 7C0 | 334= | 337= | | | | | | | | | | | | | | |
| TINDRY | -R | 2C0 | 34 | 46 | 48 | | | | | | | | | | | | | |
| TIME | -R | 19= | 76 | 269 | 270 | 311 | 327= | 327 | 330 | 334 | 336 | 337 | 357WR | 374 | 376 | 379AC | 426 | 432 |
| | | 432 | 433 | 456 | 459 | | | | | | | | | | | | | |
| TIMING | -R | 2C0 | 73= | 76 | 429 | | | | | | | | | | | | | |
| TIMWET | -R | 2C0 | 34 | 46 | | | | | | | | | | | | | | |
| TIS | ()R | 7C0 | 330= | 336= | | | | | | | | | | | | | | |
| TH | -R | 79= | 146 | 146 | 150 | 150 | 197 | 197 | 200 | 212 | 252 | 236 | 236 | 239 | 239 | 290 | | |

TOP -R 117= 162 165=
TOTRAS ()R 360 392
TOTRAW ()R 360 392
TRAS -R 364= 368= 368 371WR 383= 389= 389 390WR
TRAW -R 365= 369= 369 371WR 384= 388= 388 390WR
TRNCLD -R 366= 370= 370 371WR 385= 387= 387 390WR
TSOL -R 293= 295= 295 300
TT -R 120A 79 107WR 146 146 150 150 196 197 200 200 212 232 236 236 239 239
290
TW -R 134= 135 137 181 184= 185 346= 347 348= 350 351= 352 353 448= 449 450 451=
453= 455
TWW -R 126= 127 127= 128 130 172= 173 176 181=
V ()R 10RL 45= 46= 47= 48= 72 72= 73 74 76 100 100= 101WR 101WR 102 103 269
270 375 427 429 429 432 432 433
VOLWAT ()R 360 371WR 390WR 415
W ()R 200 80 82 87 89 91 96 119 121= 124= 126 134 155= 160 161 162= 162
164 165 166= 166 167 169 172 184 260= 262= 264= 265 265= 266 266= 268= 276
280 320 371WR 390WR 437 444 446 448 448 454 455=
WAT -R 259= 260
WATH -R 200 110WR 117 124 127 127 160 265 265 268 449 453
WATL -R 200 110WR 116 121 164 266 266 450 451
WFDD -R 103= 220= 232= 233 234= 379AC
WFUU -R 290= 291 306
WKP -R 119= 155
WRITE - 13F 39F 51F 53F 61F 65F 97F 101F 105F 107F 108F 110F 112F 114F 357F 359F 361F
371F 380F 381F 390F 394F 396F 400F 409F 411F 422F
WTSOLD ()R 360 371WR 390WR 415
XD ()R 200 400WR
XT -R 34= 35
XTIME -R 33= 46 48 49= 49
Y ()R 10RL 96= 126 134 172 184 262 264 277 289 437= 437 438 440 448 454=
YSOL ()R 10RL 300= 301
10 - 220D 24*
50 - 13WR 14*
90 - 260D 270D 28*
150 - 31D0 32*
172 - 35* 43
175 - 39WR 40*
179 - 37 44*
180 - 44D0 49*
200 - 51WR 52*
210 - 53WR 54*
220 - 50 55*
230 - 57D0 59*
240 - 61WR 62*
250 - 64D0 65*
260 - 65WR 66*
320 - 60 67*
340 - 70D0 71*
360 - 86D0 87*
370 - 88D0 93*
390 - 94D0 96*
400 - 95* 101WR 107WR 110WR 114WR 371WR 390WR 422WR
420 - 97WR 98*
430 - 99D0 101*
460 - 105WR 106*
470 - 108WR 109*
510 - 112WR 113*

```
 605  -  104    115*
 610  -  117*   457
 620  -  120    121*
 630  -  120    124*
 640  -  120    123     126*    157
 650  -  133DO  187*
 660  -  140    143*    178
 670  -  146*   180
 680  -  147    150*
 690  -  148    154*
 700  -  149    158*
 710  -  159    160*
 720  -  159    164*
 730  -  163    167*
 740  -  143    179*
 750  -  142    145     153     159     160     164     170     181*
 770  -  190DO  191*
 780  -  192*   271     284
 790  -  192DO  206     210*
 800  -  199    203*
 810  -  202    204*
 820  -  198    207*
 830  -  207    211*
 840  -  214*   216
 860  -  217DO  218     220*
 870  -  222DO  226*
 880  -  227    232*    242
 910  -  229    238*
 930  -  231    233     237     243*
 940  -  248*   255
 950  -  248    249*
 960  -  248    251*
 970  -  250    252*
 980  -  248    256     259*
 990  -  244    262*
1000  -  261    263*
1010  -  263DO  267*
1015  -  269    272*
1020  -  275DO  278     280*
1030  -  281    282     285*
1050  -  287DO  289*
1060  -  294DO  296*
1070  -  297DO  299     302*
1080  -  298    300*
1083  -  409WR  410*
1084  -  411WR  412*
1088  -  310DO  314     316*
1089  -  312    315*
1090  -  317DO  324*
1100  -  326    327*
1110  -  338DO  341*
1130  -  344*   352
1140  -  343    346*
1150  -  347    350*
1160  -  349    350     352*
1170  -  345    354*
1180  -  357WR  358*
1190  -  359WR  360*    380WR
```

1195 - 361WR 362* 381WR
1200 - 363DO 371*
1210 - 367DO 370*
1220 - 354 356 372*
1230 - 374 376* 434
1240 - 382DO 390*
1245 - 386DO 389*
1250 - 391DO 393*
1260 - 394WR 395*
1270 - 396WR 397*
1280 - 398DO 400*
1290 - 400WR 401*
1300 - 405DO 424*
1310 - 370 425*
1320 - 413DO 421 423*
1330 - 414DO 417*
1340 - 418DO 420*
1350 - 419 422*
1380 - 375 432*
1390 - 431 432 435*
1470 - 441 443*
1480 - 443DO 455*
1490 - 449 453*
1500 - 450 452 454*
1520 - 425 456 458*

```
      1           SUBROUTINE TMLIST (TIME,DETT,DELT,Q1,WFDD,SIRF,SUM1,EVAP,PIT,
     1 BALANC,CMWATB,CUMS)
            C
            C*ABSTRACT: Output of UNSAT calculations
            C
            C*AUTHOR: L ROBERTSON
            C
            C*TYPE: IO
            C
            C*PARAMETER DESCRIPTION:
            CIN         TIME - time (hours)
            CIN         DETT - Two times the lowest allowed time increment (hours)
            CIN         DELT - Time increment last used (hours)
            CIN         Q1 - Flux at top boundary
            CIN         WFDD - Soil flux
            CIN         SIRF - Cummulative rain
            CIN         SUM1 - Water in column
            CIN         EVAP - Cumulative evapotranspiration
            CIN         PIT - Original amount of water in column
            CIN         BALANC - Amount of water left at surface.
            CIN         CMWATB - Cumulative water off bottom
            CIN         CUMS - Cumulative water at surface
            C
            C*CALLED BY:
            C           UNSAT
            C
            C*CALLS TO:
            C           NONE
            C
      2           IYEAR=INT(TIME/24./365.0)
      3           IDAY=INT((TIME-IYEAR*24.*365.0)/24.)
      4           DAY=IDAY
      5           MONTH=DAY/30.
      6           IDAY=IDAY-30*MONTH
      7           WRITE (6,100)
      8       100 FORMAT (2(/))
      9           WRITE (6,110) TIME,IYEAR,MONTH,IDAY
     10       110 FORMAT (1H1,/,5X13H THE TIME IS,1PE12.4,16H HOURS, WHICH IS,I10,
     1 9H YEAR(S),,I3,14H MONTH(S), AND,I4,
     2 27H DAY(S) FROM THE BEGINNING.)
     11           WRITE (6,120) DELT,DETT
     12       120 FORMAT (/,2X,8HDELT  IS,1PE11.4,14H AND  DETT  IS,E11.4)
     13           EOR=Q1/DELT
     14           IF (EOR.LT.1E-5) WRITE (6,130)
     15       130 FORMAT (/,2X,16HDRY PERIOD)
     16           IF (EOR.LT.1E-2.AND.EOR.GE.1E-5) WRITE (6,140)
     17       140 FORMAT (/,2X,11HNORMAL RAIN)
     18           IF (EOR.GE.1E-2) WRITE (6,150)
     19       150 FORMAT (/,2X,11HMAJOR FLOOD)
     20           WRITE (6,160)
     21       160 FORMAT (/,5X,4HSOIL,5X,8HCUM RAIN,4X,8HWATER IN,3X,10HCUM EVAPO-
     +,3X,9HCUM WATER,4X,7HBALANCE,/,5X,4HFLUX,5X,9HAND FLOOD,5X,
     1 6HCOLUMN,6X,5HTRANS,5X,10HOFF BOTTOM,2X,9H% OF CUMS)
     22           WATB=CUMS-SUM1+PIT-EVAP
     23           WRITE (6,170) WFDD,SIRF,SUM1,EVAP,CMWATB,BALANC
     24       170 FORMAT (1P5E12.4,E12.4)
     25           RETURN
     26           END
```

SINGLY REFERENCED VARIABLES

RETURN - 25F TMLIST - 18U WATB -R 22=

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BALANC | -R | 1AC | 23WR | | | | | | |
| CMWATB | -R | 1AC | 23WR | | | | | | |
| CUMS | -R | 1AC | 22 | | | | | | |
| DAY | -R | 4= | 5 | | | | | | |
| DELT | -R | 1AC | 11WR | 13 | | | | | |
| DETT | -R | 1AC | 11WR | | | | | | |
| EOR | -R | 13= | 14 | 16 | 16 | 18 | | | |
| EVAP | -R | 1AC | 22 | 23WR | | | | | |
| IDAY | -I | 3= | 4 | 6= | 6 | 9WR | | | |
| IF | - | 14F | 16F | 18F | | | | | |
| INT | - | 2SU | 3SU | | | | | | |
| IYEAR | -I | 2= | 3 | 9WR | | | | | |
| MONTH | -I | 5= | 6 | 9WR | | | | | |
| PIT | -R | 1AC | 22 | | | | | | |
| QI | -R | 1AC | 13 | | | | | | |
| SIRF | -R | 1AC | 23WR | | | | | | |
| SUMI | -R | 1AC | 22 | 23WR | | | | | |
| TIME | -R | 1AC | 2 | 3 | 9WR | | | | |
| WFDD | -R | 1AC | 23WR | | | | | | |
| WRITE | - | 7F | 9F | 11F | 14F | 16F | 18F | 20F | 23F |
| 100 | - | 7WR | 8* | | | | | | |
| 110 | - | 9WR | 10* | | | | | | |
| 120 | - | 11WR | 12* | | | | | | |
| 130 | - | 14WR | 15* | | | | | | |
| 140 | - | 16WR | 17* | | | | | | |
| 150 | - | 18WR | 19* | | | | | | |
| 160 | - | 20WR | 21* | | | | | | |
| 170 | - | 23WR | 24* | | | | | | |

```
      SUBROUTINE ADSORB
C
C*ABSTRACT: Nuclide transfer between layers of soil for Shallow Land Burial.
C
C*AUTHOR: CHILDS and HANKS
C
C*TYPE: NUMERICAL ANALYSIS
C
C*CALLED BY:
C          UNSAT
C
C*CALLS TO:
C          NONE
C
C*COMMON BLOCKS:
CNAME      HYDRA
C           in, numnuc, dd, w, dnsty, xd, *ipass
CNAME      ADS
C           *draw, *dras, n, *totraw, *totras, senter, *rncld, q,
C           *rbottm, qbot, dec, *volwat, *wtsold, *raw, *ras
CNAME      VAR2
C           *rho
C
C*TECHNICAL DESCRIPTION:
C            Traces the movements of the nuclides through the soil
C            based on the flux (Q) calculations in UNSAT.
C          VARIABLE DESCRIPTIONS:
C            DRAW - Amount of nuclides in water with nuclide breakdown
C                   by layers and nuclides (decayed ci)
C            DRAS - Amount of nuclides in soil with nuclide breakdown
C                   by layers and nuclides (decayed ci)
C            TOTRAW - Total amount of nuclides in water with breakdown
C                     by nuclides (decayed ci)
C            TOTRAS - Total amount of nuclides in soil with breakdown
C                     by nuclides (decayed ci)
C            RNCLD - Amount of nuclides in each layer with breakdown
C                    by nuclides (ci)
C            RBOTTM - Amount of nuclides into the aquifer from the soil
C                     column with breakdown by nuclides (ci/ft**2)
C            WTSOLD - Weight of soil per square foot by layer (gm)
C            VOLWAT - Volume of water per square foot by layer (ml)
C            RAW - Amount of nuclides in water with nuclide breakdown
C                  by layer and nuclides (ci)
C            RAS - Amount of nuclides in soil with nuclide breakdown
C                  by layer and nuclides (ci)
C            RHO - Density of soil in top bin for use in EROSIO (lbs/ft**3)
C
     2       COMMON/HYDRA/ K,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,DD(60),
            1 P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,CONCOF(60),
            2 DNSTY(60),XD(45,60),SOLFAC(45),ORIENT(45),CUMT,IPASS
     3       COMMON/ADS/DRAW(45,60),DRAS(45,60),N,TOTRAW(45),TOTRAS(45),
            1 SENTER(45),RNCLD(45,60),Q(60),RBOTTM(45),QBOT,
            2 DEC(45),VOLWAT(60),WTSOLD(60),RAW(45,60),RAS(45,60)
     4       COMMON/VAR2/CFCT,U(10),HT,RHO
     5       DIMENSION RAWCON(45,60)
C
C            CHANGE TO MAKE RUN FASTER
C
```

```
      DIMENSION DDX(60)
       LL=N-1
      IF(IPASS.GT.0)GO TO 50
      DD1=(DD(2)-DD(1))*14158.5
      IF(N.LT.2)GO TO 40
      DDN=(DD(N)-DD(N-1))*14158.5
   40 CONTINUE
      WTSOLD(1)=DD1*DNSTY(1)
       RHO=WTSOLD(1)/((DD(2)-DD(1))*453.6)
      WTSOLD(N)=DDN*DNSTY(N)
      DO 10 I=2,LL
      DDX(I)=(DD(I+1)-DD(I-1))*14158.5
   10 WTSOLD(I)=DDX(I)*DNSTY(I)
      IPASS=IPASS+1
   50 CONTINUE
      VOLWAT(1)=DD1*W(1)
      VOLWAT(N)=DDN*W(N)
      DO 100 I=2,LL
  100 VOLWAT(I)=DDX(I)*W(I)
      DO 115 NUC=1,NUMNUC
  115 RNCLD(NUC,IN)=SENTER(NUC)+RNCLD(NUC,IN)
C
C           SORPFC  -  FRACTION OF SORBED NUCLIDE AVAILABLE FOR DESORPTION
      SORPFC=1.0
C
C   Q - MEANS UP
C   Q + MEANS DOWN
      DO 120 NUC=1,NUMNUC,1
      DO 130 LYR=2,N,1
      IF(Q(LYR))130,130,119
  119     BONDS=(1.-SORPFC)*RAS(NUC,LYR-1)
      RAS(NUC,LYR-1)=(RNCLD(NUC,LYR-1)-BONDS)/(1.0+(1.0/(XD(NUC,LYR-1)
     1*WTSOLD(LYR-1)/VOLWAT(LYR-1))))+BONDS
      RAW(NUC,LYR-1)=(RNCLD(NUC,LYR-1)-BONDS)/((WTSOLD(LYR-1)/
     1VOLWAT(LYR-1))*XD(NUC,LYR-1)+1.0)
      RAWCON(NUC,LYR-1)=RAW(NUC,LYR-1)/VOLWAT(LYR-1)*(LYR-1)*28317.
      IF (RAWCON(NUC,LYR-1).LT.1E-18) GO TO 130
      RPASS=Q(LYR)*RAWCON(NUC,LYR-1)
      IF(RPASS.GT.RAW(NUC,LYR-1))RPASS=RAW(NUC,LYR-1)
      RNCLD(NUC,LYR-1)=RNCLD(NUC,LYR-1)-RPASS
      RNCLD(NUC,LYR)=RNCLD(NUC,LYR)+RPASS
  130 CONTINUE
      RAW(NUC,N)=(RNCLD(NUC,N)-BONDS)/((WTSOLD(N)/
     1VOLWAT(N))*XD(NUC,N)+1.0)
      RAWCON(NUC,N)=RAW(NUC,N)/VOLWAT(N)*(N-1)*28317.
      DO 120 I=1,LL
      LYR=N-I+1
      IF(Q(LYR))131,120,120
  131     BONDS=(1.-SORPFC)*RAS(NUC,LYR)
      RAS(NUC,LYR)=(RNCLD(NUC,LYR)-BONDS)/(1.0+(1.0/(XD(NUC,LYR)
     1*WTSOLD(LYR)/VOLWAT(LYR))))+BONDS
      RAW(NUC,LYR)=(RNCLD(NUC,LYR)-BONDS)/((WTSOLD(LYR)/VOLWAT(LYR))
     1*XD(NUC,LYR)+1.0)
      RAWCON(NUC,LYR)=RAW(NUC,LYR)/VOLWAT(LYR)*28317.
      IF (RAWCON(NUC,LYR).LT.1E-18) GO TO 120
      RPASS=-(Q(LYR)*RAWCON(NUC,LYR))
      IF (RPASS.GT.RAW(NUC,LYR)) RPASS=RAW(NUC,LYR)
      RNCLD(NUC,LYR)=RNCLD(NUC,LYR)-RPASS
```

```
      RNCLD(NUC,LYR-1)=RNCLD(NUC,LYR-1)+RPASS
  120 CONTINUE
      DO 140 NUC=1,NUMNUC,1
      RBOTTH(NUC)=0.0
      IF(QBOT.LT.0.) GO TO 140
      RPASS=QBOT*RAWCON(NUC,N)
      IF(RPASS.GT.RAW(NUC,N)) RPASS=RAW(NUC,N)
      RBOTTH(NUC)=RPASS
      RNCLD(NUC,N)=RNCLD(NUC,N)-RPASS
      IF(RNCLD(NUC,N).LT.0.0) RNCLD(NUC,N)=0.0
  140 CONTINUE
      DO 150 NUC=1,NUMNUC,1
      TOTRAS(NUC)=0.
  150 TOTRAW(NUC)=0.
      DO 160 LYR=1,N,1
      DO 160 NUC=1,NUMNUC,1
      BONDS=(1.-SORPFC)*RAS(NUC,LYR)
      RAS(NUC,LYR)=(RNCLD(NUC,LYR)-BONDS)/(1.0+(1.0/(XD(NUC,LYR)
     1*WTSOLD(LYR)/VOLWAT(LYR))))+BONDS
      RAW(NUC,LYR)=(RNCLD(NUC,LYR)-BONDS)/((WTSOLD(LYR)/VOLWAT(LYR))
     1*XD(NUC,LYR)+1.0)
      DRAW(NUC,LYR)=RAW(NUC,LYR)*DEC(NUC)
      DRAS(NUC,LYR)=RAS(NUC,LYR)*DEC(NUC)
      TOTRAW(NUC)=TOTRAW(NUC)+DRAW(NUC,LYR)
      TOTRAS(NUC)=TOTRAS(NUC)+DRAS(NUC,LYR)
      IF (RNCLD(NUC,LYR).LT.1E-18) RNCLD(NUC,LYR)=0.
      IF (DRAW(NUC,LYR).LT.1E-18) DRAW(NUC,LYR)=0.
      IF (DRAS(NUC,LYR).LT.1E-18) DRAS(NUC,LYR)=0.
  160 CONTINUE
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ADS | - | 3CN | CONC | -R | 2CO | E | ()R | 2CO | HYDRA | '- | 2CN | P | ()R | 2CO | TIMDRY | -R | 2CO | VAR2 | - | 4CN |
| ADSORB | - | 1SU | CURF | -R | 2CO | EDRY | -R | 2CO | K | -I | 2CO | RAIN | -R | 2CO | TIMINC | -R | 2CO | VATH | -R | 2CO |
| CFCT | -R | 4CO | DELW | -R | 2CO | HT | -R | 4CO | ND | -I | 2CO | RETURN | - | 81F | TIMWET | -R | 2CO | VATL | -R | 2CO |
| CORCOF | ()R | 2CO | DRY | -R | 2CO | HWET | -R | 2CO | ORIENT | ()R | 2CO | SOLFAC | ()R | 2CO | U | ()R | 4CO | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BORDS | -R | 31* | 32 | 32 | 33 | 41 | 46* | 47 | 47 | 48 | 70* | 71 | 71 | 72 | | | | | |
| COMMON | - | 2F | 3F | 4F | | | | | | | | | | | | | | | |
| DD | ()R | 2CO | 9 | 9 | 11 | 11 | 14 | 14 | 17 | 17 | | | | | | | | | |
| DD1 | -R | 9* | 13 | 21 | | | | | | | | | | | | | | | |
| DDR | -R | 11* | 15 | 22 | | | | | | | | | | | | | | | |
| DDX | ()R | 6D1 | 17* | 18 | 24 | | | | | | | | | | | | | | |
| DEC | ()R | 3CO | 73 | 74 | | | | | | | | | | | | | | | |
| DIMENS | - | 5F | 6F | | | | | | | | | | | | | | | | |
| DUSTY | ()R | 2CO | 15 | 16 | 18 | | | | | | | | | | | | | | |
| DVAS | ()R | 3CO | 74* | 76 | 79 | 79* | | | | | | | | | | | | | |
| DVAW | ()R | 3CO | 73* | 75 | 78 | 78* | | | | | | | | | | | | | |
| I | -I | 16D0 | 17 | 17 | 17 | 18 | 18 | 18 | 23D0 | 24 | 24 | 24 | 43D0 | 44 | | | | | |
| IF | - | 8F | 10F | 30F | 35F | 37F | 45F | 50F | 52F | 58F | 60F | 63F | 77F | 78F | 79F | | | | |
| IR | -I | 2CO | 26 | 26 | | | | | | | | | | | | | | | |
| IPASS | -I | 2CO | 8 | 19* | 19 | | | | | | | | | | | | | | |
| LL | -I | 7* | 16D0 | 23D0 | 43D0 | | | | | | | | | | | | | | |
| LYR | -I | 29D0 | 30 | 31 | 32 | 32 | 32 | 32 | 32 | 33 | 33 | 33 | 33 | 33 | 34 | 34 | 34 | 34 | |
| | | 35 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 44* | 45 | 46 | 47 | 47 | 47 | 47 | 47 | |
| | | 48 | 48 | 48 | 48 | 48 | 49 | 49 | 49 | 50 | 51 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | |
| | | 60D0 | 70 | 71 | 71 | 71 | 71 | 71 | 72 | 72 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | |
| | | 76 | 77 | 77 | 78 | 78 | 79 | 79 | | | | | | | | | | | |
| N | -I | 3CO | 7 | 10 | 11 | 11 | 15 | 15 | 22 | 22 | 29D0 | 41 | 41 | 41 | 41 | 41 | 42 | 42 | |
| | | 42 | 42 | 44 | 59 | 60 | 60 | 62 | 62 | 63 | 63 | 68D0 | | | | | | | |
| NOC | -I | 25D0 | 26 | 26 | 26 | 28D0 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 35 | 36 | 37 | |
| | | 37 | 38 | 38 | 39 | 39 | 41 | 41 | 41 | 42 | 42 | 46 | 47 | 47 | 47 | 48 | 48 | 48 | |
| | | 49 | 49 | 50 | 51 | 52 | 52 | 53 | 53 | 54 | 54 | 56D0 | 57 | 59 | 60 | 60 | 61 | 62 | |
| | | 62 | 63 | 63 | 65D0 | 66 | 67 | 69D0 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 73 | |
| | | 74 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 77 | 77 | 78 | 78 | 79 | 79 | | | |
| NUMNOC | -I | 2C0 | 25D0 | 28D0 | 56D0 | 65D0 | 69D0 | | | | | | | | | | | | |
| O | ()R | 3CO | 30 | 36 | 45 | 51 | | | | | | | | | | | | | |
| OBOT | -R | 3CO | 58 | 59 | | | | | | | | | | | | | | | |
| RAS | ()R | 3CO | 31 | 32* | 46 | 47* | 70 | 71* | 74 | | | | | | | | | | |
| RAW | ()R | 3CO | 33* | 34 | 37 | 37 | 41* | 42 | 48* | 49 | 52 | 52 | 60 | 60 | 72* | 73 | | | |
| RAWCON | ()R | 6D1 | 34* | 36 | 36 | 42* | 49* | 50 | 51 | 59 | | | | | | | | | |
| RBOTTH | ()R | 3CO | 57* | 61* | | | | | | | | | | | | | | | |
| RHO | -R | 4CO | 14* | | | | | | | | | | | | | | | | |
| RHOLD | ()R | 3CO | 26* | 26 | 32 | 33 | 38* | 38 | 39* | 39 | 41 | 47 | 48 | 53* | 53 | 54* | 54 | 62* | |
| | | 62 | 63 | 63* | 71 | 72 | 77 | 77* | | | | | | | | | | | |
| RPASS | -R | 36* | 37 | 37* | 38 | 39 | 51* | 52 | 52* | 53 | 54 | 59* | 60 | 60* | 61 | 62 | | | |
| SENTER | ()R | 3CO | 26 | | | | | | | | | | | | | | | | |
| SORPFC | -R | 27* | 31 | 46 | 70 | | | | | | | | | | | | | | |
| TOTRAS | ()R | 3CO | 66* | 76* | 76 | | | | | | | | | | | | | | |
| TOTRAW | ()R | 3CO | 67* | 75* | 75 | | | | | | | | | | | | | | |
| VOLMAT | ()R | 3CO | 21* | 22* | 24* | 32 | 33 | 34 | 41 | 42 | 47 | 48 | 49 | 71 | 72 | | | | |
| W | ()R | 2CO | 21 | 22 | 24 | | | | | | | | | | | | | | |
| WTSOLD | ()R | 3CO | 13* | 14 | 15* | 18* | 32 | 33 | 41 | 47 | 48 | 71 | 72 | | | | | | |
| XD | ()R | 2CO | 32 | 33 | 41 | 47 | 48 | 71 | 72 | | | | | | | | | | |
| 10 | - | 16D0 | 10* | | | | | | | | | | | | | | | | |
| 40 | - | 10 | 12* | | | | | | | | | | | | | | | | |
| 50 | - | 0 | 20* | | | | | | | | | | | | | | | | |
| 100 | - | 23D0 | 24* | | | | | | | | | | | | | | | | |

```
INDEX -  2500  26*
119   -  30    31*
120   -  2800  4300  45    45    50    55*
130   -  2900  30    30    35    40*
131   -  45    46*
140   -  5600  58    64*
150   -  6500  67*
160   -  6800  6900  80*
```

```
      SUBROUTINE FIXTIM(ITNUM)
C
C*ABSTRACT: Subroutine to adjust time and dose arrays neede for
C           EROSIO and AQUIFR.
C
C*AUTHOR: L ROBERTSON NOVEMBER 17 , 1980
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTIONS:
CIN       ITNUM - The dose and time array counter.
C                 ITNUM = 26  EROSIO input dose and time array adjustment
C                 ITNUM = 11  AQUIFR input dose and time array adjustment
C
C*CALLED BY:
C          UNSAT
C
C*CALLS TO:
C          NONE
C
C*COMMON BLOCKS:
CNAME       HYDRA
C            numnuc
CNAME       DAQUA
C            *dosex, *ti, *it, *dosee, *tia, *ita
C
      COMMON/HYDRA/ KNUM,ND,IN,NUMNUC,DELW,RAIN,DRY,TIMWET,TIMDRY,
     1 DD(60),P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,
     2 CONCOF(60),DNSTY(60),XD(45,60),SOLFAC(45),ORICNT(45),CUMT,IPASS
      COMMON/DAQUA/DOSEX(45,26),TI(26),IT,DOSEE(45,11),TIA(11),ITA
      IF(ITNUM.GT.25) GO TO 1
      IF(ITNUM.GT.10) GO TO 100
      STOP 30
    1 LL=2
      JOUT=0
    4 L100=25-JOUT
      DO 7 I=LL,L100
      DO 5 K=1,NUMNUC
      IF(DOSEX(K,I-1).GT.0.0.OR.DOSEX(K,I).GT.0.0) GO TO 7
    5 CONTINUE
      JJ=I+1
      GO TO 8
    7 CONTINUE
      GO TO 9
    8 L100=25-JOUT
      DO 6 L=JJ,L100
      TI(L-1)=TI(L)
      DO 3 K=1,NUMNUC
      DOSEX(K,L-1)=DOSEX(K,L)
    3 CONTINUE
    6 CONTINUE
      JOUT=JOUT+1
      LL=JJ
      IF(JJ.GT.L100) GO TO 9
      GO TO 4
    9  ITNUM=ITNUM-JOUT+1
      IT=ITNUM
      IF(JOUT.EQ.0) GO TO 15
```

```
      DO 16 I=ITNUM,26
      TI(I)=0.0
      DO 17 K=1,NUMNUC
      DOSEX(K,I)=0.0
   17 CONTINUE
   16 CONTINUE
   15 IF(ITNUM.LT.26) RETURN
      J=1
      DO 10 I=2,24,2
      DO 20 K=1,NUMNUC
      TEMP=DOSEX(K,I-1)*(TI(I)-TI(I-1))+DOSEX(K,I)*(TI(I+1)-TI(I))
      DOSEX(K,J)=TEMP/(TI(I+1)-TI(I-1))
   20 CONTINUE
      TI(J)=TI(I-1)
      J=J+1
   10 CONTINUE
      DO 18 K=1,NUMNUC
      DOSEX(K,13)=DOSEX(K,25)
   18 CONTINUE
      TI(13)=TI(25)
      ITNUM=14
      IT=ITNUM
      DO 22 I=14,26
      TI(I)=0.0
      DO 21 K=1,NUMNUC
      DOSEX(K,I)=0.0
   21 CONTINUE
   22 CONTINUE
      RETURN
  100 LL=2
      JOUT=0
  104 L10=10-JOUT
      DO 107 I=LL,L10
      DO 105 K=1,NUMNUC
      IF(DOSEE(K,I-1).GT.0.0.OR.DOSEE(K,I).GT.0.0) GO TO 107
  105 CONTINUE
      JJ=I+1
      GO TO 108
  107 CONTINUE
      GO TO 109
  108 L10=10-JOUT
      DO 106 L=JJ,L10
      TIA(L-1)=TIA(L)
      DO 103 K=1,NUMNUC
      DOSEE(K,L-1)=DOSEE(K,L)
  103 CONTINUE
  106 CONTINUE
      JOUT=JOUT+1
      LL=JJ
      IF(LL.GT.L10) GO TO 109
      GO TO 104
  109 ITNUM=ITNUM-JOUT+1
      ITA=ITNUM
      IF(JOUT.EQ.0) GO TO 115
      DO 116 I=ITNUM,11
      TIA(I)=0.0
      DO 117 K=1,NUMNUC
      DOSEE(K,I)=0.0
```

```
      117  CONTINUE
      116 CONTINUE
      115  IF(ITNUM.LT.11) RETURN
           J=1
           DO 110 I=2,10,2
           DO 120 K=1,NUMNUC
           TEMP=DOSEE(K,I-1)*(TIA(I)-TIA(I-1))+DOSEE(K,I)*(TIA(I+1)-TIA(I))
           DOSEE(K,J)=TEMP/(TIA(I+1)-TIA(I-1))
      120  CONTINUE
           TIA(J)=TIA(I-1)
           J=J+1
      110  CONTINUE
           ITNUM=6
           ITA=ITNUM
           DO 122 I=6,11
           TIA(I)=0.0
           DO 121 K=1,NUMNUC
           DOSEE(K,I)=0.0
      121  CONTINUE
      122  CONTINUE
           RETURN
           END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CONCOF | ()R | 2C0 | DELW | -R | 2C0 | HDRY | -R | 2C0 | KNUM | (-I | 2C0 | SOLFAC | ()R | 2C0 | W | ()R | 2C0 |
| CONQ | -R | 2C0 | DNSTY | ()R | 2C0 | HWET | -R | 2C0 | ND | -I | 2C0 | STOP | - | 6F | WATH | -R | 2C0 |
| CUMT | -R | 2C0 | DRY | -R | 2C0 | HYDRA' | - | 2CN | ORIGNT | ()R | 2C0 | TIMDRY | -R | 2C0 | WATL | -R | 2C0 |
| DAQUA | - | 3CN | E | ()R | 2C0 | IN | -I | 2C0 | P | ()R | 2C0 | TIMINC | -R | 2C0 | XD | ()R | 2C0 |
| DD | ()R | 2C0 | FIXTIM | - | 1SU | IPASS | -I | 2C0 | RAIN | .-P | 2C0 | TIMWET | -R | 2C0 | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COMMON | - | 2F | 3F | | | | | | | | | | | | | | |
| DOSEE | ()R | 3C0 | 66 | 66 | 76* | 76 | 89* | 96 | 96 | 97* | 107* | | | | | | |
| DOSEX | ()R | 3C0 | 12 | 12 | 22* | 22 | 35* | 42 | 42 | 43* | 49* | 49 | 57* | | | | |
| I | -I | 10D0 | 12 | 12 | 14 | 32D0 | 33 | 35 | 40D0 | 42 | 42 | 42 | 42 | 42 | 43 | 43 | 45 |
| | | 54D0 | 55 | 57 | 64D0 | 66 | 66 | 68 | 86D0 | 87 | 89 | 94D0 | 96 | 96 | 96 | 96 | 96 | 96 |
| | | 97 | 97 | 99 | 104D0 | 105 | 107 | | | | | | | | | | |
| IF | - | 4F | 5F | 12F | 27F | 31F | 38F | 66F | 81F | 85F | 92F | | | | | | |
| IT | -I | 3C0 | 30* | 53* | | | | | | | | | | | | | |
| ITA | -I | 3C0 | 84* | 103* | | | | | | | | | | | | | |
| ITNUM | -I | 1AC | 4 | 5 | 29* | 29 | 30 | 32D0 | 38 | 52* | 53 | 83* | 83 | 84 | 86D0 | 92 | 102* | 103 |
| J | -I | 39* | 43 | 45 | 46* | 46 | 93* | 97 | 99 | 100* | 100 | | | | | | | |
| JJ | -I | 14* | 19D0 | 26 | 27 | 68* | 73D0 | 80 | | | | | | | | | | |
| JOUT | -I | 8* | 9 | 18 | 25* | 25 | 29 | 31 | 62* | 63 | 72 | 79* | 79 | 83 | 85 | | | |
| K | -I | 11D0 | 12 | 12 | 21D0 | 22 | 22 | 34D0 | 35 | 41D0 | 42 | 42 | 43 | 48D0 | 49 | 49 | 56D0 | 57 |
| | | 65D0 | 66 | 66 | 75D0 | 76 | 76 | 88D0 | 89 | 95D0 | 96 | 96 | 97 | 106D0 | 107 | | | |
| L | -I | 19D0 | 20 | 20 | 22 | 22 | 73D0 | 74 | 74 | 76 | 76 | | | | | | | |
| L10 | -I | 63* | 64D0 | 72* | 73D0 | 81 | | | | | | | | | | | | |
| L100 | -I | 9* | 10D0 | 18* | 19D0 | 27 | | | | | | | | | | | | |
| LL | -I | 7* | 10D0 | 26* | 61* | 64D0 | 80* | 81 | | | | | | | | | | |
| NUMNUC | -I | 2C0 | 11D0 | 21D0 | 34D0 | 41D0 | 48D0 | 56D0 | 65D0 | 75D0 | 88D0 | 95D0 | 106D0 | | | | | |
| RETURN | - | 38F | 60F | 92F | 110F | | | | | | | | | | | | | |
| TEMP | -R | 42* | 43 | 96* | 97 | | | | | | | | | | | | | |
| TI | ()R | 3C0 | 20* | 20 | 33* | 42 | 42 | 42 | 42 | 43 | 43 | 45* | 45 | 51* | 51 | 55* | | |
| TIA | ()R | 3C0 | 74* | 74 | 87* | 96 | 96 | 96 | 96 | 97 | 97 | 99* | 99 | 105* | | | | |
| 1 | - | 4 | 7* | | | | | | | | | | | | | | | |
| 3 | - | 21D0 | 23* | | | | | | | | | | | | | | | |
| 4 | - | 9* | 28 | | | | | | | | | | | | | | | |
| 5 | - | 11D0 | 13* | | | | | | | | | | | | | | | |
| 6 | - | 19D0 | 24* | | | | | | | | | | | | | | | |
| 7 | - | 10D0 | 12 | 16* | | | | | | | | | | | | | | |
| 8 | - | 15 | 18* | | | | | | | | | | | | | | | |
| 9 | - | 17 | 27 | 29* | | | | | | | | | | | | | | |
| 10 | - | 40D0 | 47* | | | | | | | | | | | | | | | |
| 15 | - | 31 | 38* | | | | | | | | | | | | | | | |
| 16 | - | 32D0 | 37* | | | | | | | | | | | | | | | |
| 17 | - | 34D0 | 36* | | | | | | | | | | | | | | | |
| 18 | - | 48B0 | 50* | | | | | | | | | | | | | | | |
| 20 | - | 41D0 | 44* | | | | | | | | | | | | | | | |
| 21 | - | 56D0 | 58* | | | | | | | | | | | | | | | |
| 22 | - | 54D0 | 59* | | | | | | | | | | | | | | | |
| 100 | - | 5 | 61* | | | | | | | | | | | | | | | |
| 103 | - | 75D0 | 77* | | | | | | | | | | | | | | | |
| 104 | - | 63* | 82 | | | | | | | | | | | | | | | |
| 105 | - | 65D0 | 67* | | | | | | | | | | | | | | | |
| 106 | - | 73D0 | 78* | | | | | | | | | | | | | | | |
| 107 | - | 64D0 | 66 | 70* | | | | | | | | | | | | | | |
| 108 | - | 69 | 72* | | | | | | | | | | | | | | | |
| 109 | - | 71 | 81 | 83* | | | | | | | | | | | | | | |
| 110 | - | 94D0 | 101* | | | | | | | | | | | | | | | |
| 115 | - | 85 | 92* | | | | | | | | | | | | | | | |

```
INDEX   -    86DO   91*
116     -    88DO   90*
117     -    95DO   98*
120     -   106DO  108*
121     -   104DO  109*
122
```

```
      SUBROUTINE AQUIFR(II,IJ)
C
C*ABSTRACT: A computer code for predicting radionuclide decay chain
C           transport thru geologic media.
C
C*AUTHOR: WV DE MIER     AUGUST , 1979
C         MO CLONINGER       GETOUT (PNL2970,UC70)
C         PJ LIDDELL         PACIFIC NORTHWEST LABORATORY)
C         MODIFIED BY D LESTER    MAY 21 , 1980
C
C*TYPE: NUMERICAL ANALYSIS)
C
C*PARAMETER DESCRIPTIONS:
CIN       II - Nuclide identification for the case being run.
CIN       IJ - Identifies the time frame being examined.
C
C*CALLED BY:
C           EXEC
C
C*CALLS TO:
C         SWD
C
C*COMMON BLOCKS:
CNAME       XDATA
C            name, iprnt
CNAME       AQUA
C            xz, ei, vz, ti, tz, rnwv
CNAME       HDATA
C            half
CNAME       DAQUA
C            dosee
CNAME       TSTEP
C            *ddd
CNAME       PI
C            *pi
CNAME       FFFFG
C            *ac, *r, *cin
C
C*TECHNICAL DESCRIPTION:
C             Computes the radionuclide decay chain transport for a
C             single nuclide migration.
C           VARIABLE DESCRIPTIONS:
C             DDD - Dose after traveling thru the aquifer. (ci)
C             AC - Ratio of water velocity to nuclide velocity
C             R - Number of years water particle takes to travel the
C                 length of the aquifer times decay constant of nuclide (years)
C             CIN - Initial amount of nuclide at start of aquifer. (ci)
C
2           DOUBLE PRECISION EL2,THRSHD,PI,AC,R,CIN,PEC,ETA,THETA,
           1 RNW,DLAM,AM1,SWD1
3           COMMON/XDATA/NAME(45,2),N,ITITLE(12),IPRNT
4           COMMON/AQUA/ XZ,EI,VZ,TI,TZ,RNWV(45)
5           COMMON/HDATA/ HALF(45)
6           COMMON/DAQUA/DOSEX(45,26),AMT(26),IT,DOSEE(45,11),TIA(11),ITA
7           COMMON /TSTEP/
           +     T(100,45),D(100,45),DDD(100)
8           COMMON /PI/
           +     PI
```

```
 9            COMMON /FFFFG/
             +     AC,          R,          CIN,
             +     PEC,         ETA,        THETA
       C     EL2 IS NATURAL LOG OF 2.
10           DATA EL2 /0.69314718D0/
11           DATA THRSHD /1.D-35/
12           DATA PI /3.14159265D0/
       C     IN THE FOLLOWING DO LOOP,
       C       RNW IS RATIO OF NUCLIDE VELOCITY TO WATER VELOCITY
       C      DLAM IS DECAY CONSTANT
       C...
       C...    BEGIN LOOPING THROUGH NUCLIDE LIST
       C...
       C...
13           I=II
14           KT=IJ
       C
       C      ZERO ARRAYS
15             DO 130 K=1,100
16           DDD(K)=0.0
17       130   CONTINUE
18             RNW=RNWV(I)
19             DLAM=HALF(I)
20             ANI=DOSEE(I,KT)
21             R=DLAM*XZ/VZ
22             PEC=VZ*XZ/EI
23             ETA=1.
24             AC=1.D0/RNW
25           NS=100
       C...
       C...
       C... BEGIN LOOPING THROUGH TIME STEPS
       C...
       C...
26         160 DO 180 J=2,NS
27               SWDI=0.0D0
28               CIN=ANI
29               THETA=(T(J,I)-TZ)*VZ/XZ
30               IF (THETA.LE.0.0D0) GO TO 180
       C
       C... CALCULATE DISCHARGE RATES FOR SPECIFIED RELEASE MODES.
       C
31                CALL SWD (SWDI)
32               IF (SWDI.LT.THRSHD) SWDI=0.0D0
33               DDD(J)=SWDI
34         180   CONTINUE
       C...
       C...
       C...  END OF TIME-LOOP
       C...
       C...
35           DTOT=0
36             DO 200 J=2,NS
37           DTOT=DDD(J)+DTOT
38         200   CONTINUE
39           IF(IPRNT.EQ.2) WRITE (6,310)(NAME(I,J),J=1,2), DTOT,DOSEE(I,KT)
            1 ,TZ,TI
40         210 CONTINUE
```

```
      RETURN
310 FORMAT (1X,2A3,2X,1PE12.3,3X,22HTOTAL DOSE FROM UNSAT ,1PE12.3,2X,
     1 4HTZ= 1PE12.3,2X,4HTI= ,1PE12.3)
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AMT | ()R | 6CO | D | ()R | 7CO | FFFFC | - | 9CN | ITITLE() | I | 3CO | TIA | ()R | 6CO | 160 | - | 26* | | |
| AQUA | - | 4CN | DAQUA | - | 6CN | HDATA( | - | 5CN | N | -I | 3CO | TSTEP | - | 7CN | 210 | - | 40* | | |
| AQUIFR | - | 1SU | DOSEX | ()R | 6CO | IT | -I | 6CO | RETURN | - | 41F | WRITE | - | 39F | | | | | |
| CALL | - | 31F | DOUBLE | - | 2F | ITA | -I | 6CO | SWD | - | 31SU | XDATA | - | 3CN | | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AC | -D | 2DB | 9CO | 24= | | | | |
| AN1 | -D | 2DB | 20= | 28 | | | | |
| CIN | -D | 2DB | 9CO | 28= | | | | |
| COMMON | - | 3F | 4F | 5F | 6F | 7F | 8F | 9F |
| DATA | - | 10F | 11F | 12F | | | | |
| DDD | ()R | 7CO | 16= | 33= | 37 | | | |
| DLAM | -D | 2DB | 19= | 21 | | | | |
| DOSEE | ()R | 6CO | 20 | 39WR | | | | |
| DTOT | -R | 35= | 37= | 37 | 39WR | | | |
| E1 | -R | 4CO | 22 | | | | | |
| EL2 | -D | 2DB | 10DA | | | | | |
| ETA | -D | 2DB | 9CO | 23= | | | | |
| HALF | ()R | 5CO | 19 | | | | | |
| I | -I | 13= | 18 | 19 | 20 | 29 | 39WR | 39WR |
| IF | - | 30F | 32F | 39F | | | | |
| II | -I | 1AC | 13 | | | | | |
| IJ | -I | 1AC | 14 | | | | | |
| IPRNT | -I | 3CO | 39 | | | | | |
| J | -I | 26DO | 29 | 33 | 36DO | 37 | 39WR | 39WR |
| K | -I | 15DO | 16 | | | | | |
| KT | -I | 14= | 20 | 39WR | | | | |
| NAME | ()I | 3CO | 39WR | | | | | |
| NS | -I | 25= | 26DO | 36DO | | | | |
| PEC | -D | 2DB | 9CO | 22= | | | | |
| PI | - | 2DB | 8CN | 8CO | 12DA | | | |
| R | -D | 2DB | 9CO | 21= | | | | |
| RNW | -D | 2DB | 18= | 24 | | | | |
| RNWV | ()R | 4CO | 18 | | | | | |
| SWD1 | -D | 2DB | 27= | 31AC | 32 | 32= | 33 | |
| T | ()R | 7CO | 29 | | | | | |
| T1 | -R | 4CO | 39WR | | | | | |
| THETA | -D | 2DB | 9CO | 29= | 30 | | | |
| THRSHD | -D | 2DB | 11DA | 32 | | | | |
| TZ | -R | 4CO | 29 | 39WR | | | | |
| VZ | -R | 4CO | 21 | 22 | 29 | | | |
| XZ | -R | 4CO | 21 | 22 | 29 | | | |
| 130 | - | 15DO | 17* | | | | | |
| 180 | - | 26DO | 30 | 34* | | | | |
| 200 | - | 36DO | 38* | | | | | |
| 310 | - | 39WR | 42* | | | | | |

```
      SUBROUTINE FF10 (FIDE,FIDA)
C
C*ABSTRACT:
C
C*AUTHOR: WV DE MIER ET AL   AUGUST , 1979
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
COUT     FIDE - Used in the expression below to calculate the dose in curies
C               at the end of the aquifer.
COUT     FIDA - SAME
C                DOSE(CI)=FIDA*EXP(FIDE)
C
C*CALLED BY:
C          SWD
C
C*CALLS TO:
C          FF10, FERRNT, SUM2
C
C*COMMON BLOCKS:
CNAME      AQUA
C           sclt, vt, tt
CNAME      FFFFC
C           ac, r, cin, p, eta, theta
CNAME      NEGXER
C           expcmi, erfcmi
C
C*TECHNICAL DESCRIPTION:
C
      DOUBLE PRECISION AC,R,CIN,P,ETA,THETA,FIDE,FIDA,TL1,
     1 TR1,DIFF1,EERF11,TERF11,EXPCM1,E1,ERFCM1,A1,E,A,V,SCL,T,
     2 TL2,TR2,DIFF2,EERF12,TERF12,E2,A2,E4,A4,SUMT1,EERF21,
     3 TERF21,E3,A3,SUMT2,EERF22,TERF22
      COMMON/AQUA/ SCLT,EIX,VT,TT,TZ,RNWV(45)
      COMMON /FFFFC/
     +    AC,          R,          CIN,
     +    P,           ETA,        THETA
      COMMON /NEGXER/
     +    EXPCM1,      ERFCM1
      TL1=ETA/2.E0*DSQRT(AC*P/THETA)
      TR1=DSQRT(P*THETA/(4.E0*AC))
      V=VT
      SCL=SCLT
      T=TT
      DIFF1=TL1-TR1
      CALL FERRNT (DIFF1,DUM,EERF11,TERF11)
      E1=EXPCM1
      A1=ERFCM1
      IF (THETA-T*V/SCL.GT.0.0D0) GO TO 100
      E=EERF11
      A=TERF11
      GO TO 130
  100 TL2=ETA/2.D0*DSQRT(AC*P/(THETA-T*V/SCL))
      TR2=DSQRT(P*(THETA-T*V/SCL)/(4.D0*AC))
      DIFF2=TL2-TR2
      CALL FERRNT (DIFF2,DUM,EERF12,TERF12)
      E2=EXPCM1
```

```
      A2=ERFCN1
      IF (DIFF1.LT.0.D0.AND.DIFF2.LT.0.D0) GO TO 110
      IF (DIFF1.LT.0.D0.OR.DIFF2.LT.0.D0) GO TO 120
  110 CALL SUM2 (E1,A1,E2,-A2,E,A)
      IF (DIFF1.GE.0..OR.DIFF2.GE.0.) GO TO 130
      A=-A
      GO TO 130
  120 CALL SUM2 (E1,A1,E2,A2,E,A)
      E4=0.0D0
      A4=2.0D0
      CALL SUM2 (E,A,E4,-A4,E,A)
      IF (DIFF1.LT.0.0D0) A=-A
  130 SUMT1=TL1+TR1
      CALL FERRNT (SUMT1,DUM,EERF21,TERF21)
      IF (THETA-T*V/SCL.GT.0.0D0) GO TO 140
      E3=EERF21
      A3=TERF21
      GO TO 150
  140 SUMT2=TL2+TR2
      CALL FERRNT (SUMT2,DUM,EERF22,TERF22)
      CALL SUM2 (EERF21,TERF21,EERF22,-TERF22,E3,A3)
  150 E3=E3+P*ETA
      CALL SUM2 (E,A,E3,A3,FIDE,FIDA)
      FIDE=FIDE-R*THETA
      FIDA=FIDA*CIN/2.0D0/T
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

AQUA - 3CN E1X -R 3C0 FFFFC - 4CN RETURN - 49F TZ -R 3C0
DOUBLE - 2F FF10 - 1SU NEGXER - 5CN RNWV ()R 3C0

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -D | 2DB | 17= | 27AC | 29= | 29 | 31AC | 34AC | 34AC | 35= | 35 | 46AC |
| A1 | -D | 2DB | 14= | 27AC | 31AC | | | | | | | |
| A2 | -D | 2DB | 24= | 27AC | 31AC | | | | | | | |
| A3 | -D | 2DB | 40= | 44AC | 46AC | | | | | | | |
| A4 | -D | 2DB | 33= | 34AC | | | | | | | | |
| AC | -D | 2DB | 4C0 | 6 | 7 | 19 | 20 | | | | | |
| CALL | - | 12F | 22F | 27F | 31F | 34F | 37F | 43F | 44F | 46F | | |
| CIN | -D | 2DB | 4C0 | 48 | | | | | | | | |
| COMMON | - | 3F | 4F | 5F | | | | | | | | |
| DIFF1 | -D | 2DB | 11= | 12AC | 25 | 26 | 28 | 35 | | | | |
| DIFF2 | -D | 2DB | 21= | 22AC | 25 | 26 | 28 | | | | | |
| DSQRT | - | 6SU | 7SU | 19SU | 20SU | | | | | | | |
| DUM | -R | 12AC | 22AC | 37AC | 43AC | | | | | | | |
| E | -D | 2DB | 16= | 27AC | 31AC | 34AC | 34AC | 46AC | | | | |
| E1 | -D | 2DB | 13= | 27AC | 31AC | | | | | | | |
| E2 | -D | 2DB | 23= | 27AC | 31AC | | | | | | | |
| E3 | -D | 2DB | 39= | 44AC | 45= | 45 | 46AC | | | | | |
| E4 | -D | 2DB | 32= | 34AC | | | | | | | | |
| EERF11 | -D | 2DB | 12AC | 16 | | | | | | | | |
| EERF12 | -D | 2DB | 22AC | | | | | | | | | |
| EERF21 | -D | 2DB | 37AC | 39 | 44AC | | | | | | | |
| EERF22 | -D | 2DB | 43AC | 44AC | | | | | | | | |
| ERFCH1 | -D | 2DB | 5C0 | 14 | 24 | | | | | | | |
| ETA | -D | 2DB | 4C0 | 6 | 19 | 45 | | | | | | |
| EXPCH1 | -D | 2DB | 5C0 | 13 | 23 | | | | | | | |
| FERRNT | - | 12SU | 22SU | 37SU | 43SU | | | | | | | |
| FIDA | -D | 1AC | 2DB | 46AC | 48= | 48 | | | | | | |
| FIDE | -D | 1AC | 2DB | 46AC | 47= | 47 | | | | | | |
| IF | - | 15F | 25F | 26F | 28F | 35F | 38F | | | | | |
| P | -D | 2DB | 4C0 | 6 | 7 | 19 | 20 | 45 | | | | |
| R | -D | 2DB | 4C0 | 47 | | | | | | | | |
| SCL | -D | 2DB | 9= | 15 | 19 | 20 | 38 | | | | | |
| SCLT | -R | 3C0 | 9 | | | | | | | | | |
| SUM2 | - | 27SU | 31SU | 34SU | 44SU | 46SU | | | | | | |
| SUMT1 | -D | 2DB | 36= | 37AC | | | | | | | | |
| SUMT2 | -D | 2DB | 42= | 43AC | | | | | | | | |
| T | -D | 2DB | 10= | 15 | 19 | 20 | 38 | 48 | | | | |
| TERF11 | -D | 2DB | 12AC | 17 | | | | | | | | |
| TERF12 | -D | 2DB | 22AC | | | | | | | | | |
| TERF21 | -D | 2DB | 37AC | 40 | 44AC | | | | | | | |
| TERF22 | -D | 2DB | 43AC | 44AC | | | | | | | | |
| THETA | -D | 2DB | 4C0 | 6 | 7 | 15 | 19 | 20 | 38 | 47 | | |
| TL1 | -D | 2DB | 6= | 11 | 36 | | | | | | | |
| TL2 | -D | 2DB | 19= | 21 | 42 | | | | | | | |
| TR1 | -D | 2DB | 7= | 11 | 36 | | | | | | | |
| TR2 | -D | 2DB | 20= | 21 | 42 | | | | | | | |
| TT | -R | 3C0 | 10 | | | | | | | | | |
| V | -D | 2DB | 8= | 15 | 19 | 20 | 38 | | | | | |
| VT | -R | 3C0 | 8 | | | | | | | | | |
| 100 | - | 15 | 19* | | | | | | | | | |
| 110 | - | 25 | 27* | | | | | | | | | |
| 120 | - | 26 | 31* | | | | | | | | | |
| 130 | - | 18 | 28 | 30 | 36* | | | | | | | |

```
140  -    38      42*
150  -    41      45*
```

```
      SUBROUTINE FERRNT (X,ERF,EXPC1,ERFC1)
C
C*ABSTRACT: This subroutine calculates both the erf x and the erfc x
C                to the maximum machine accuracy possible.
C
C*AUTHOR: I A STEGUN       SET.  1970
C         R ZUCKER       JOURNAL OF RESEARCH, NBS,
C                      VOL 74B, NO. 3, JULY-SEPT 1970  PP 211-224
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       X - The real value we received from FF10 and will base calculation on.
COUT      ERF - Function of x
COUT      EXPC1 - Used to calculate erfc(x)
COUT      ERFC1 - Used to calculate erfc(x)
C                 ERFC(X) = ERFC1 * EXP(EXPC1)
C
C*CALLED BY:
C         FF10
C
C*CALLS TO:
C         NONE
C
C*COMMON BLOCKS:
CNAME     NEGXER
C          *expcm1, *erfcm1
C
C*TECHNICAL DESCRIPTION:
C         VARIABLE DESCRIPTIONS:
C           EXPCM1 - Variable used in SUM2 to obtain a value for E and F.
C           ERFCM1 - Also used to find the values for E and F.
C     NBC=NO. OF BINARY DIGITS IN THE CHARACTERISTIC OF A FLOATING POINT
C     NUMBER.
C     NBM=ACCURACY DESIRED OR MAX. NO. OF BINARY DIGITS IN THE MANTISSA
C     OF A FLOATING POINT NUMBER.
      COMMON /NEGXER/
     +     EXPCM1,          ERFCM1
      DOUBLE PRECISION
     +     AN,              BN,              C1,              CONS,
     +     DN,              ERF,                              ERFC1,
     +     EXPC1,           F,               FACTR,           FN,
     +     FNM1,            FNM2,            FOUR,            GN,
     +     GNM1,            GNM2,            ONE,             PREV,
     +     PWR,             RNBC,            SCF,             SUM,
     +     TN,              TOLER,           TRRTP1,          TWO,
     +     ULCF,            ULPS,            WN,              X,
     +     Y,               YSQ,             ZERO,
     +     ERFCM1,          EXPCM1
      DATA NBC,NBM/8,62/
      DATA TRRTP1/1.128379167095512574D0/
C     ---- CDC CYBER 74 VALUES
C     DATA NBC,NBM/11,96/
C     DATA TRRTP1/1.128379167095512573896158903 1D0/
      DATA ZERO,ONE,TWO,FOUR,ULPS,CONS/0.D0,1.D0,2.D0,4.D0,1.D0,.83D0/
C
      RNBC=NBC
      TOLER=TWO**(-NBM)
```

```
      C
      C     ---- TEST ON ZERO
      C
      9       IF (X) 110,100,110
      C
     10     100 ERF=ZERO
     11         ERFC1=ONE
     12         EXPC1=ZERO
     13         EXPCM1=EXPC1
     14         ERFCM1=ERFC1
     15         GO TO 200
      C
      C     .
     16     110 Y=DABS(X)
     17         YSQ=Y**2
      C
     18         IF (Y-ULPS) 140,140,120
      C
      C     ---- MAXIMUM ARGUMENT
     19     120 C1=TWO**((RNBC-ONE)/TWO)
     20         ULCF=CONS*C1
      C
      C     ---- SCALE FACTOR
     21         SCF=TWO**(C1**2-RNBC)
      C
      C     ---- LIMITING VALUE
      C
     22         IF (Y-ULCF) 210,210,130
      C
     23     130 FACTR=0.
     24         GO TO 220
      C
      C     ---- METHOD - POWER SERIES
     25     140 SUM=ZERO
     26         DN=ONE
     27         TN=ONE
     28         PWR=TWO*YSQ
     29         IF(YSQ.LT.35.) GO TO 149
     30         FACTR=0.
     31         GO TO 150
     32     149 FACTR=DEXP(-YSQ)
      C
     33     150 DN=DN+TWO
     34         TN=PWR*TN/DN
     35         SUM=TN+SUM
      C
      C     ---- TOLERANCE CHECK
      C
     36         IF (TN-TOLER) 160,150,150
      C
     37     160 ERF=(SUM+ONE)*Y*FACTR*TRUTP1
     38         ERFC1=ONE-ERF
     39         EXPC1=ZERO
      C
     40     170 ERFCM1=ERFC1
     41         EXPCM1=EXPC1
     42         IF (X) 180,200,200
      C
```

```
      C     ---- NEGATIVE ARGUMENT
   43   180 ERF=-ERF
   44       IF (EXPC1.EQ.ZERO) GO TO 190
   45       ERFC1=TWO-ERFC1*FACTR
   46       EXPC1=ZERO
   47       GO TO 200
   48   190 ERFC1=TWO-ERFC1
      C
   49   200 RETURN
      C
      C     ---- METHOD - CONTINUED FRACTION
   50       IF(YSQ.LT.35.) GO TO 210
   51       FACTR=0.
   52       GO TO 220
   53   210 FACTR=DEXP(-YSQ)
   54   220 FNM2=ZERO
   55       GNM2=ONE
   56       FNM1=TWO*Y
   57       GNM1=TWO*YSQ+ONE
   58       PREV=FNM1/GNM1
   59       WN=ONE
   60       BN=GNM1+FOUR
   61   230 AN=-WN*(WN+ONE)
   62       FN=BN*FNM1+AN*FNM2
   63       GN=BN*GNM1+AN*GNM2
   64       F=FN/GN
      C
      C     ---- TOLERANCE CHECK
      C
   65       IF (DABS(ONE-(F/PREV))-TOLER) 280,280,240
   66   240 IF (PREV-F) 250,250,270
   67   250 IF (GN.LT.1.0D35) GO TO 260
      C
      C     ---- SCALING
   68       FN=FN/SCF
   69       GN=GN/SCF
   70       FNM1=FNM1/SCF
   71       GNM1=GNM1/SCF
      C
   72   260 FNM2=FNM1
   73       GNM2=GNM1
   74       FNM1=FN
   75       GNM1=GN
   76       WN=WN+TWO
   77       BN=BN+FOUR
   78       PREV=F
   79       GO TO 230
      C
   80   270 F=PREV
   81   280 ERFC1=F/TWO*TRRTPI
   82       ERF=ONE-ERFC1*FACTR
   83       EXPC1=-YSQ
   84       GO TO 170
   85       END
```

SINGLY REFERENCED VARIABLES

COMMON - 2F DOUBLE - 3F FERRNT - 1SU NEGXER - 2CN RETURN - 49F

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | -D | 3DB | 61= | 62 | 63 | | | | | | | | | | |
| BK | -D | 3DB | 60= | 62 | 63 | 77= | 77 | | | | | | | | |
| CI | -D | 3DB | 19= | 20 | 21 | | | | | | | | | | |
| CONS | -D | 3DB | 6DA | 20 | | | | | | | | | | | |
| DABS | - | 16SU | 65SU | | | | | | | | | | | | |
| DATA | - | 4F | 5F | 6F | | | | | | | | | | | |
| DEXP | - | 32SU | 53SU | | | | | | | | | | | | |
| DK | -D | 3DB | 26= | 33= | 33 | 34 | | | | | | | | | |
| ERF | -D | 1AC | 3DB | 10= | 37= | 38 | 43= | 43 | 82= | | | | | | |
| ERFC1 | -D | 1AC | 3DB | 11= | 14 | 38= | 40 | 45= | 45 | 48= | 48 | 81= | 82 | | |
| ERFCM1 | -D | 2CO | 3DB | 14= | 10= | | | | | | | | | | |
| EXPC1 | -D | 1AC | 3DB | 12= | 13 | 39= | 41 | 44 | 46= | 83= | | | | | |
| EXPCM1 | -D | 2CO | 3DB | 13= | 41= | | | | | | | | | | |
| F | -D | 3DB | 64= | 65 | 66 | 78 | 80= | 81 | | | | | | | |
| FACTR | -D | 3DB | 23= | 30= | 32= | 37 | 45 | 51= | 53= | 82 | | | | | |
| FN | -D | 3DB | 62= | 64 | 68= | 68 | 74 | | | | | | | | |
| FNM1 | -D | 3DB | 56= | 58 | 62 | 70= | 70 | 72 | 74= | | | | | | |
| FNM2 | -D | 3DB | 54= | 62 | 72= | | | | | | | | | | |
| FOUR | -D | 3DB | 6DA | 60 | 77 | | | | | | | | | | |
| GK | -D | 3DB | 63= | 64 | 67 | 69= | 69 | 75 | | | | | | | |
| GKM1 | -D | 3DB | 57= | 58 | 60 | 63 | 71= | 71 | 73 | 75= | | | | | |
| GKM2 | -D | 3DB | 55= | 63 | 73= | | | | | | | | | | |
| IF | - | 9F | 18F | 22F | 29F | 36F | 42F | 44F | 50F | 65F | 66F | 67F | | | |
| NBC | -I | 4DA | 7 | | | | | | | | | | | | |
| NBM | -I | 4DA | 8 | | | | | | | | | | | | |
| ONE | -D | 3DB | 6DA | 11 | 19 | 26 | 27 | 37 | 38 | 55 | 57 | 59 | 61 | 65 | 82 |
| PREV | -D | 3DB | 58= | 65 | 66 | 78= | 80 | | | | | | | | |
| PWR | -D | 3DB | 28= | 34 | | | | | | | | | | | |
| RNBC | -D | 3DB | 7= | 19 | 21 | | | | | | | | | | |
| SCF | -D | 3DB | 21= | 68 | 69 | 70 | 71 | | | | | | | | |
| SUM | -D | 3DB | 25= | 35= | 35 | 37 | | | | | | | | | |
| TN | -D | 3DB | 27= | 34= | 34 | 35 | 36 | | | | | | | | |
| TOLER | -D | 3DB | 8= | 36 | 65 | | | | | | | | | | |
| TRTPI | -D | 3DB | 5DA | 37 | 81 | | | | | | | | | | |
| TWO | -D | 3DB | 6DA | 8 | 19 | 19 | 21 | 28 | 33 | 45 | 48 | 56 | 57 | 76 | 81 |
| ULCF | -D | 3DB | 20= | 22 | | | | | | | | | | | |
| ULPS | -D | 3DB | 6DA | 18 | | | | | | | | | | | |
| WN | -D | 3DB | 59= | 61 | 61 | 76= | 76 | | | | | | | | |
| X | -D | 1AC | 3DB | 9 | 16 | 42 | | | | | | | | | |
| Y | -D | 3DB | 16= | 17 | 18 | 22 | 37 | 56 | | | | | | | |
| YSQ | -D | 3DB | 17= | 28 | 29 | 32 | 50 | 53 | 57 | 83 | | | | | |
| ZERO | -D | 3DB | 6DA | 10 | 12 | 25 | 39 | 44 | 46 | 54 | | | | | |
| 100 | - | 9 | 10* | | | | | | | | | | | | |
| 110 | - | 9 | 9 | 16* | | | | | | | | | | | |
| 120 | - | 18 | 19* | | | | | | | | | | | | |
| 130 | - | 22 | 23* | | | | | | | | | | | | |
| 140 | - | 18 | 18 | 25* | | | | | | | | | | | |
| 149 | - | 29 | 32* | | | | | | | | | | | | |
| 150 | - | 31 | 33* | 36 | 36 | | | | | | | | | | |
| 160 | - | 36 | 37* | | | | | | | | | | | | |
| 170 | - | 40* | 84 | | | | | | | | | | | | |
| 180 | - | 42 | 43* | | | | | | | | | | | | |
| 190 | - | 44 | 48* | | | | | | | | | | | | |
| 200 | - | 15 | 42 | 42 | 47 | 49* | | | | | | | | | |

```
210  -    22      22      50      53*
220  -    24      52      54*
230  -    61*     79
240  -    65      66*
250  -    66      66      67*
260  -    67      72*
270  -    66      80*
280  -    65      65      81*
```

```
      SUBROUTINE CNT (NS,I)
C
C*ABSTRACT: Set up time line for each nuclide within the aquifer.
C
C*AUTHOR: WV DE MIER    ET. AL.
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTIONS:
CIN       NS - Variable set at 100 within EXEC.  A higher value would
C              shift the time line up.
CIN       I - Nuclide identification number for this run.
C
C*CALLED BY:
C          EXEC
C
C*CALLS TO:
C          NONE
C
C*COMMON BLOCKS:
CNAME       AQUA
C            xz, vz, tz
CNAME       FFFFC
C            ac
CNAME       TSTEP
C            *t
C
C*TECHNICAL DESCRIPTION:
C             Sets up a seperate time line containg 100 points for
C             each nuclide.
C           VARIABLE DESCRIPTIONS:
C             T - Time line (years)
C
      DOUBLE PRECISION AC,R,CIN,PEC,ETA,THETA,S1
      COMMON/AQUA/XZ,E1,VZ,T1,TZ,RNWV(45)
      COMMON /FFFFC/
     +    AC,           R,           CIN,
     +    PEC,          ETA,         THETA
      COMMON/TSTEP/ T(100,45),D(100,45),DDD(100)
      S1=1.14D0
      NS3=NS/3
      ACT=AC
      T(NS3,I)=ACT*XZ/VZ+TZ
      JK=(NS3)-1
      DO 100 J=JK,1,-1
      TT=S1**(2*(NS3-J))
        T(J,I)=T(J+1,I)-TT
  100 CONTINUE
      JK=JK+2
      DO 110 J=JK,NS
      TT=S1**(2*(J-NS3))
        T(J,I)=T(J-1,I)+TT
  110 CONTINUE
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | |

```
      SUBROUTINE SUM2 (A,B,C,D,E,F)
C
C*ABSTRACT: Routine which calculates E and F so as to solve the following
C           equation:      ERFC(X) = F * EXP(E)
C
C*AUTHOR: WV DE MIER, ET AL  AUGUST , 1979
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       A - Variable calculated in subroutine FF10 at time t0 or
C             upon entering the aquifer.
CIN       B - Also refer to FF10 with variable A.
CIN       C - Variable calculated in subroutine FF10 at time tf or
C             upon leaving the aquifer.
CIN       D - Also refer to FF10 with variable C.
COUT      E - Variable arrived at using A, B, C, D in order to solve
C             the equation stated above.
COUT      F - Solved in conjunction with E.
C
C*CALLED BY:
C          FF10
C
C*CALLS TO:
C          NONE
C
C*TECHNICAL DESCRIPTION:
C
C       DEXP(E)*F=DEXP(A)*B+DEXP(C)*D
      IMPLICIT
     +     DOUBLE PRECISION (A-H,O-Z)
      IF (B.EQ.0.) GO TO 120
      IF (D.EQ.0.) GO TO 140
C     ----B.NE.0..AND.D.NE.0.
      XL=A
      ZA=ABS(B)
      ZL=DLOG(ZA)
      IZ=ZL
      ZI=IZ
      ZL=ZL-ZI
      TL=DSIGN(DEXP(ZL),B)
      XL=XL+ZI
      XR=C
      ZA=ABS(D)
      ZL=DLOG(ZA)
      IZ=ZL
      ZI=IZ
      ZL=ZL-ZI
      TR=DSIGN(DEXP(ZL),D)
      XR=XR+ZI
      E=XR
      IF (XL.GT.XR) E=XL
      C=XR-E
C               CHANGED 706 TO 84
      IF (C.GT.-84.D0) GO TO 100
      E=XL
      F=TL
      RETURN
```

```
      C                CHANGED 706 TO 84
   28   100 IF (C.GT.84.D0) C=84.D0
   29       IF (C.NE.0.) TR=DEXP(C)*TR
   30       C=XL-E
      C                CHANGED 706 TO 84
   31       IF (C.GT.-84.D0) GO TO 110
   32       E=XR
   33       F=TR
   34       RETURN
      C                CHANGED 706 TO 84
   35   110 IF (C.GT.84.D0) C=84.D0
   36       IF (C.NE.0.) TL=DEXP(C)*TL
   37       F=TL+TR
   38       RETURN
   39   120 IF (D.EQ.0.) GO TO 130
      C     -----B.EQ.0.AND  D.NE.0.
   40       E=C
   41       F=D
   42       RETURN
      C     -----B.EQ.0.  AND  D.EQ.0.
   43   130 E=0.
   44       F=0.
   45       RETURN
      C     -----B.NE.0.  AND D.EQ.0.
   46   140 E=A
   47       F=B
   48       RETURN
   49       END
```

SINGLY REFERENCED VARIABLES
SUM2 -C 1SU

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -C | 1AC | 5 | 46 | | | | | | | | |
| ABS | - | 6SU | 14SU | | | | | | | | | |
| B | -C | 1AC | 3 | 6 | 11 | 47 | | | | | | |
| C | -C | 1AC | 13 | 40 | | | | | | | | |
| D | -C | 1AC | 4 | 14 | 19 | 39 | 41 | | | | | |
| DEXI | - | 11SU | 19SU | 29SU | 36SU | | | | | | | |
| DLOG | - | 7SU | 15SU | | | | | | | | | |
| DSIGN | - | 11SU | 19SU | | | | | | | | | |
| E | -C | 1AC | 21= | 22= | 23 | 25= | 30 | 32= | 40= | 43= | 46= | |
| F | -C | 1AC | 26= | 33= | 37= | 41= | 44= | 47= | | | | |
| | -D | 23= | 24 | 28 | 28= | 29 | 29 | 30= | 31 | 35 | 35= | 36 | 36 |
| IF | - | 3SU | 4F | 22F | 24F | 28F | 29F | 31F | 35F | 36F | 39F | |
| IZ | -I | 8= | 9 | 16= | 17 | | | | | | | |
| RETURN | - | 27F | 34F | 38F | 42F | 45F | 48F | | | | | |
| TL | -D | 11= | 26 | 36= | 36 | 37 | | | | | | |
| TR | -D | 19= | 29= | 29 | 33 | 37 | | | | | | |
| XL | -D | 5= | 12= | 12 | 22 | 22 | 25 | 30 | | | | |
| XR | -D | 13= | 20= | 20 | 21 | 22 | 23 | 32 | | | | |
| ZA | -D | 6= | 7 | 14= | 15 | | | | | | | |
| ZI | -D | 9= | 10 | 12 | 17= | 18 | 20 | | | | | |
| ZL | -D | 7= | 8 | 10= | 10 | 11 | 15= | 16 | 18= | 18 | 19 | |
| 100 | - | 24 | 28* | | | | | | | | | |
| 110 | - | 31 | 35* | | | | | | | | | |
| 120 | - | 3 | 39* | | | | | | | | | |
| 130 | - | 39 | 43* | | | | | | | | | |
| 140 | - | 4 | 46* | | | | | | | | | |

```
      SUBROUTINE SWD (SWD1)
C
C*ABSTRACT: Routine which finally calculates
C                ERFC(X) = F * EXP(E)
C
C*AUTHOR: WV DE MIER, ET AL  AUGUST ; 1979
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
COUT     SWD1 - The variable equivalent to ERFC(X).
C
C*CALLED BY:
C         AQUIFR
C
C*CALLS TO:
C         FF10
C
C*COMMON BLOCKS:
CNAME      FFFFC
C           theta
C
C*TECHNICAL DESCRIPTION:
C
      DOUBLE PRECISION AC,R,CIN,P,ETA,THETA,SWD1,F10E1,F10A1
      LOGICAL LSW
      COMMON /FFFFC/
     +     AC,          R,          CIN,
     +     P,          ETA,          THETA
C             CHANGED 708 TO 84
      DATA EXPMIN/84.D0/
      LSW=.TRUE.
      CALL FF10 (F10E1,F10A1)
      SWD1=0.0D0
C             84 USED TO BE 704
      IF(F10E1.GT.84.D0) LSW=.FALSE.
      IF(.NOT.LSW) WRITE(6,9000) THETA,F10E1,F10A1
      IF(.NOT.LSW) RETURN
      IF (F10E1.GT.-EXPMIN) SWD1=F10A1*DEXP(F10E1)
      RETURN
 9000 FORMAT(/42H CALCULATIONS  WERE DISCONTINUED AT THETA=,E12.4,2X,
     1 7HF10E1= ,E12.4,2X,7HF10A1= ,E12.4,5X17H(F10A1*EXP(F10E1))
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALL | - | 7F | DATA | - | 5F | DOUBLE | - | 2F | FFFFC | - | 4CN |
| COMMON | - | 4F | DEXP | - | 12SU | FF10 | - | 7SU | LOGICA | - | 3F |
| SWD | - | 1SU | WRITE | - | 10F | | | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AC | -D | 2DB | 4CO | | | | |
| CIN | -D | 2DB | 4CO | | | | |
| ETA | -D | 2DB | 4CO | | | | |
| EXPMIN | -R | 5DA | 12 | | | | |
| F10A1 | -D | 2DB | 7AC | 10WR | 12 | | |
| F10E1 | -D | 2DB | 7AC | 9 | 10WR | 12 | 12 |
| IF | - | 9F | 10F | 11F | 12F | | |
| LSW | -L | 3LC | 6* | 9* | 10 | 11 | |
| P | -D | 2DB | 4CO | | | | |
| R | -D | 2DB | 4CO | | | | |
| RETURN | - | 11F | 13F | | | | |
| SWD1 | -D | 1AC | 2DB | 8* | 12* | | |
| THETA | -D | 2DB | 4CO | 10WR | | | |
| 9000 | - | 10WR | 14* | | | | |

```
      1       SUBROUTINE EROSIO
              C
              C*ABSTRACT: Routine which takes nuclide from the top of the soil
              C           column and blows them into the air.
              C
              C*AUTHOR:
              C
              C*TYPE: NUMERICAL ANALYSIS!
              C
              C*CALLED BY:
              C         EXEC
              C
              C*CALLS TO:
              C         COMPUT
              C
              C*COMMON BLOCKS:
              CNAME       ATMO1
              C            nss, f, fr, rf
              CNAME       VAR
              C            pag84, *rdght, *rdgsp, *ang, *wndfrc, *htbr, fw,
              C            *r, *a, *ans, *sair, nu, fl, angl, mat, angwnd, *icall
              CNAME       XDATA
              C            name, iprnt
              CNAME       EROS
              C            nuc, time, dens, xnucin, *xncout
              CNAME       VAR2
              C            *cfct, u, ht, rho
              C
              C*TECHNICAL DESCRIPTION:
              C             This subroutine takes the nuclide output from UNSAT and
              C             calculates the amount of each nuclide that will be airborne.
              C           VARIABLE DESCRIPTIONS:
              C             WNDFRC - Wind!ratio. The strongest wind direction
              C                      versus the wind perpendicular to it.
              C             A - Height of standing grain (meters)
              C             ICALL - Variable which says we have already calculated ANS
              C                     so do not need to calculate it again.
              C             ANS - Amount of soil thrown into air by the wind erosion.
              C                   (tons/acre/year)
              C             XNCOUT - The amount of each nuclide thrown into the air (ci)
              C             CFCT - Climatic factor (dimensionless)
              C
      2           REAL MAXTIM
      3           COMMON/ATMO1/NS,NSS,F(10,7),FR,RF
      4           COMMON/VAR/ PAG84,KLSP,RDGHT,RDGSP,ANG,WNDFRC,HTBR,
                 1 FW,R,A,CK5,CK6,CK8,CK9,CK11,
                 X CK13,CK1,CK2,CK3,CK4,ANS,SAIR,NU,FL,ANGL,MAT,ANGWND,ICALL
      5           REAL KLSP, MAT,MAP
      6           COMMON/XDATA/NAME(45,2),N,ITITLE(12),IPRNT
      7           COMMON/EROS/NUC,TIME,DENS,XNUCIN(45),XNCOUT(45)
      8           COMMON/VAR2/ CFCT,U(10),HT,RHO
      9           IF(ICALL.NE.0) GO TO 10
     10           ICALL =1
     11           RDGHT=RDGHT*39.37
     12           RDGSP=RDGSP*39.37
     13           HTBR=HTBR*39.37/12.
     14           R=R*8903.4
     15           A=HT*39.37
```

```
C      ABOVE STATEMENTS CONVERT METRIC INPUT DATA TO ENGLISH UNITS
      MAP=RF*1000.
         SAIR = SAIR/100.
      SUM=0
      SUMC=0
      DO 103 J=1,NU,1
      IF(U(J)-5.36)103,101,101
  101 DO 102 I=1,NSS
      SUMC=SUMC+F(J,I)
      SUM=SUM + U(J)*F(J,I)
  102 CONTINUE
C        CALCULATION OF WIND SPEEDS > 12MPH WEIGHTED BY DURATION FACTORS
      SUMC=SUMC + 1.
C      CALCULATION OF WEIGHTED WIND FORCES >12MPH
  103 CONTINUE
          IF(MAT .LE. 10.) GO TO  105
      IF(MAP .LE. 0.) GO TO  106
      CFCT= .345*(SUM/SUMC/.447)**3./(115.*(MAP/(MAT-10.))**(10./9.))**2.
C      CALCULATION OF CLIMACTIC FACTOR
         GO TO 170
  105 WRITE(6,167)
  167 FORMAT(' ANNUAL TEMPERATURE MUST BE GREATER THAN 10. DEGREES ',
     X 'CENTIGRADE')
      GO TO 129
  106 WRITE(6,168)
  168 FORMAT(' ANNUAL PRECIPITATION MUST BE GREATER THAN 0.')
      GO TO 129
  170 THSUBR = 0
      THSUBR=ANGWND
         RANGL1 = ANGL + 90.
         RANGL2 = ANGL - 90.
C       RANGL1,2 ARE THE RIGHT ANGLES TO FIELD STRIP DIRECTION(ANGL)
C       MEASURED FROM EAST AS 0 DEGREES
       IF(RANGL2.LT.0.0) RANGL2 = RANGL2 + 360.
       DIFF1 = ABS(THSUBR - RANGL1)
       DIFF2 = ABS(THSUBR - RANGL2)
C        DIFF1,2 ARE THE ANGLES OF DEVIATION BETWEEN EROSIVE WIND
C        DIRECTION AND RIGHT ANGLES TO FIELD STRIP ON EITHER SIDE
C        OF FIELD STRIP
       IF(DIFF1 - DIFF2)172,173,173
  172 ANG = DIFF1
         GO TO 174
  173 ANG = DIFF2
C       ANG IS ORIGINAL WEROS INPUT DATA
  174 ANS=R
      WNDFRC=4.
      IF(ANG.LT.1.0) GO TO 175
      WNDFRC=COS(ANG*3.14159/180.)/SIN(ANG*3.14159/180)
  175 IF(WNDFRC.GT.4.) WNDFRC=4.
      IF(WNDFRC.LT.1.) WNDFRC=1.
      CALL COMPUT
C        ORIGINAL SOIL LOSS IN TONS/ACRE/YEAR RETURNED HERE
      DO 113 I=1,NUC
      XNCOUT(I)=0.
  113 CONTINUE
      IF(ANS.EQ.0.0) GO TO 10
      MAXTIM = 2.52*DENS*(1.-PAC84/100.)/.224/ANS
   10 IF(ANS.EQ.0.) GO TO 129
```

```
      IF(MAXTIM-TIME) 115,116,116
C       COMPARES INPUT TIME WITH MAXTIM TO DETERMINE IF WIND CAN
C       BLOW AS LONG AS DESIRED
  115 DO 118 I=1,NUC
        XNCOUT(I) = ANS*FL*FW*SAIR*XNUCIN(I)*MAXTIM*2000./(RHO*43560.)
C     CURIES LOFTED BASED ON SOIL LOSS, FIELD AREA, PERCENT AIRBORNE,
C     NUCLIDES IN SOIL, AND MAXTIM
  118 CONTINUE
      GO TO 120
  116 DO 119 I=1,NUC
        XNCOUT(I) = ANS*FL*FW*SAIR*XNUCIN(I)*TIME*2000./(RHO*43560.)
C       CURIES LOFTED AS ABOVE EXCEPT TIME IS INPUT TIME
  119 CONTINUE
  120 DO 121 I=1,NUC
      IF(XNCOUT(I).GT.0.0) GO TO 123
  121 CONTINUE
      GO TO 129
  123 IF(IPRNT.NE.2) GO TO 129
      WRITE(6,125) ((NAME(I,J),J=1,2),XNCOUT(I),XNUCIN(I),I=1,NUC)
  125 FORMAT (1X,2A3,2X,1PE10.2,3X,22HTOTAL DOSE FROM HYDRO ,1PE10.2)
  129 RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATM01 | - | 5CN | CK13 | -R | 4C0 | CK5 | -R | 4C0 | COMPUT | - | 55SU | FR | -R | 3C0 | NS | -I | 3C0 | VAR | - | 4CN |
| CALL | - | 55F | CK2 | -R | 4C0 | CK6 | -R | 4C0 | COS | - | 52SU | ITITLE() | I | 6C0 | RDCRCH | -R | 4C0 | VAR2 | - | 0CN |
| CK1 | -R | 4C0 | CK3 | -R | 4C0 | CK8 | -R | 4C0 | EROS | - | 7CN | KS | -I | 3C0 | RETURN | - | 77F | XDATA | - | 6CN |
| CK11 | -R | 4C0 | CK4 | -R | 4C0 | CK9 | -R | 4C0 | EROSIO | - | 1SU | N | -I | 6C0 | SIN | - | 52SU | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 4C0 | 15* | | | | | | | | | | | | | |
| ABS | - | 43SU | 44SU | | | | | | | | | | | | | |
| ANG | -R | 4C0 | 46* | 48* | 51 | 52 | 52 | | | | | | | | | |
| ANGL | -R | 4C0 | 40 | 41 | | | | | | | | | | | | |
| ANGWRD | -R | 4C0 | 39 | | | | | | | | | | | | | |
| ANS | -R | 4C0 | 49* | 59 | 60 | 61 | 64 | 68 | | | | | | | | |
| CFCT | -R | 8C0 | 30* | | | | | | | | | | | | | |
| COMMON | - | 3F | 4F | 6F | 7F | 8F | | | | | | | | | | |
| DENS | -R | 7C0 | 60 | | | | | | | | | | | | | |
| DIFF1 | -R | 43* | 45 | 46 | | | | | | | | | | | | |
| DIFF2 | -R | 44* | 45 | 48 | | | | | | | | | | | | |
| F | ()R | 3C0 | 23 | 24 | | | | | | | | | | | | |
| FL | -R | 4C0 | 64 | 68 | | | | | | | | | | | | |
| FW | -R | 4C0 | 64 | 68 | | | | | | | | | | | | |
| HT | -R | 8C0 | 15 | | | | | | | | | | | | | |
| HTBR | -R | 4C0 | 13* | 13 | | | | | | | | | | | | |
| I | -I | 22D0 | 23 | 24 | 56D0 | 57 | 63D0 | 64 | 64 | 67D0 | 68 | 68 | 70D0 | 71 | 75WR | 75WR | 75WR | 75WR |
| ICALL | -I | 4C0 | 9 | 10* | | | | | | | | | | | | |
| IF | - | 9F | 21F | 28F | 29F | 42F | 45F | 51F | 53F | 54F | 59F | 61F | 62F | 71F | 74F | | | |
| IPRNT | -I | 6C0 | 74 | | | | | | | | | | | | | |
| J | -I | 20D0 | 21 | 23 | 24 | 24 | 75WR | 75WR | | | | | | | | |
| KLSP | -R | 4C0 | 5RL | | | | | | | | | | | | | |
| MAP | -R | 5RL | 16* | 29 | 30 | | | | | | | | | | | |
| MAT | -R | 4C0 | 5RL | 28 | 30 | | | | | | | | | | | |
| MAXTIM | -R | 2RL | 60* | 62 | 64 | | | | | | | | | | | |
| NAME | ()I | 6C0 | 75WR | | | | | | | | | | | | | |
| NSS | -I | 3C0 | 22D0 | | | | | | | | | | | | | |
| NU | -I | 4C0 | 20D0 | | | | | | | | | | | | | |
| NUC | -I | 7C0 | 56D0 | 63D0 | 67D0 | 70D0 | 75WR | | | | | | | | | |
| PAC84 | -R | 4C0 | 60 | | | | | | | | | | | | | |
| R | -R | 4C0 | 14* | 14 | 49 | | | | | | | | | | | |
| RANGL1 | -R | 40* | 43 | | | | | | | | | | | | | |
| RANGL2 | -R | 41* | 42 | 42* | 42 | 44 | | | | | | | | | | |
| RDCHT | -R | 4C0 | 11* | 11 | | | | | | | | | | | | |
| RDCSP | -R | 4C0 | 12* | 12 | | | | | | | | | | | | |
| REAL | - | 2F | 5F | | | | | | | | | | | | | |
| RF | -R | 3C0 | 16 | | | | | | | | | | | | | |
| RHO | -R | 8C0 | 64 | 68 | | | | | | | | | | | | |
| SAIR | -R | 4C0 | 17* | 17 | 64 | 68 | | | | | | | | | | |
| SUM | -R | 18* | 24* | 24 | 30 | | | | | | | | | | | |
| SUMC | -R | 19* | 23* | 23 | 26* | 26 | 30 | | | | | | | | | |
| THSUBR | -R | 30* | 39* | 43 | 44 | | | | | | | | | | | |
| TIME | -R | 7C0 | 62 | 68 | | | | | | | | | | | | |
| U | ()R | 8C0 | 21 | 24 | | | | | | | | | | | | |
| WNDFRC | -R | 4C0 | 50* | 52* | 53 | 53* | 54 | 54* | | | | | | | | |
| WRITE | - | 32F | 35F | 75F | | | | | | | | | | | | |
| XRCOUT | ()R | 7C0 | 57* | 64* | 68* | 71 | 75WR | | | | | | | | | |
| XRUCIN | ()R | 7C0 | 64 | 68 | 75WR | | | | | | | | | | | |
| 10 | - | 9 | 59 | 61* | | | | | | | | | | | | |
| 101 | - | 21 | 21 | 22* | | | | | | | | | | | | |
| 102 | - | 22D0 | 25* | | | | | | | | | | | | | |

```
104  -    20DO    21      27*
105  -    20      32*
106  -    27      35*
113  -    56D0    58*
115  -    62      63*
116  -    62      62      67*
117  -    63DO    65*
119  -    67DO    69*
120  -    66      70*
121  -    70DO    72*
123  -    71      74*
125  -    75WR    76*
129  -    34      37      61      73      74      77*
167  -    32WR    33*
168  -    35WR    36*
170  -    31      38*
172  -    45      46*
173  -    45      45      48*
174  -    47      49*
175  -    51      53*
```

```
      1       BLOCK DATA
              C
              C*ABSTRACT: Block data for wind erosion.
              C
              C*AUTHOR: L ROBERTSON  NOVEMBER 17 1980
              C
              C*TYPE: BLOCK DATA
              C
              C*COMMON BLOCKS:
              CNAME       VAR1
              C            *erod, *wndern, *rrough, *vegcvr, *wind, *sollss, *scale
              C
              C*TECHNICAL DESCRIPTION:
              C               Block for erosion model.
              C            VARIABLE DESCRIPTIONS:
              C             WIND - Table containing soil loss (percent) vs windward knoll
              C                    slope (percent).  Used with KLSP, CK1, and CK2.
              C             EROD - Table containing soil erodibility in tons/acre as a
              C                    function of dry soil fraction gt 0.84 mm. (PAC84)
              C             RROUGH - Table containing soil ridge roughness factor vs.
              C                      soil ridge roughness in inches.
              C             WNDERN - Table relating percent of wind erosion forces traveling
              C                      distances equal to or greater than k times field width
              C                      for various preponderances of wind erosion forces in
              C                      prevailing wind erosion direction.  There are 6
              C                      curves representing angles of deviation of prevailing
              C                      wind erosion direction from right angles to the field
              C                      strip.  These angles in order are 0., 10., 20., 30., 40.,
              C                      and 50 degrees.
              C             SOLLSS - Table to determine E4 in subroutine FLRM from E2 and
              C                      E3 and from an unsheltered distance across the field.
              C             SCALE - Table containing the scales used in conjunction with SOLLSS
              C             VEGCVR - Table containing vegetative cover data in thousands of
              C                      pounds per acre vs. thousands of equivalent pounds
              C                      per acre.
      2       COMMON/VAR1/ WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),
             1 WNDERN(2,11,6),SOLLSS(21,35),SCALE(2,44),VEGCVR(2,9,9)
      3       DIMENSION SW(189),SY(189),SX(189),SZ(168)
      4       EQUIVALENCE (SW(1),SOLLSS(1,1)),(SX(1),SOLLSS(1,10))
      5       EQUIVALENCE (SY(1),SOLLSS(1,19)),(SZ(1),SOLLSS(1,28))
      6       DATA EROD/0.,310.0,250.0,220.0,195.0,180.0,170.0,160.0,150.0,140.,
             1 134.0,131.0,128.0,125.0,121.0,117.0,113.0,109.0,106.0,102.,
             2  98., 95., 92., 90., 88., 86., 83., 81., 79., 76.,
             3  74., 72., 71., 69., 67., 65., 63., 62., 60., 58.,
             4    56., 54., 52., 51., 50., 48., 47., 45., 43., 41.,
             5    38., 36., 33., 31., 29., 27., 25., 24., 23., 22.,
             6    21., 20., 19., 18., 17., 16., 16., 15., 14., 13.,
             7    12., 11., 10.,  8.,  7.,  6.,  4.,  3.,  3.,  2.,
             8     2.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,0./
      7       DATA WNDERN/1.,1.90,1.20,1.55,1.40,1.40,1.60,1.30, 1.80,1.2,
             1  2.,  1.19,2.40,1.15,3.,  1.09,3.60,1.06,4., 1.05,
             2 0.,  0.,  1.,  1.9,1.2,  1.6,  1.4,  1.46,  1.6,1.4,
             3  1.80, 3.30, 2.,  1.30, 2.40, 1.25, 3.,  1.20, 3.60,1.18,
             4  4.,  1.17, 0.,  0.,  1.,  1.90, 1.20, 1.70, 1.40,1.55,
             5  1.60, 1.46, 1.80, 1.40, 2.,  1.35, 2.40, 1.31, 3., 1.32,
             6  3.60, 1.32, 4.,  1.35, 0.,  0.,  1.,  1.90, 1.40,1.63,
             7  1.60, 1.55, 1.80, 1.48, 2.,  1.44, 2.20, 1.41, 2.4,1.40,
             8  2.60, 1.40, 3.,  1.43, 3.40, 1.48, 4.,  1.61, 1., 1.90,
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```
     9  1.45,  1.76,  1.80,  1.70,  2.,   1.67,  2.20,  1.66,  2.40, 1.66,
     A  2.60,  1.67,  3.,   1.75,  3.40,  1.09,  4.,   2.22,  0.0,  0.0,
     B  1.,   1.90,  1.80,  2.,   2.40,  2.12,  2.60,  2.16,  2.80, 2.18,
     C  3.,   2.29,  3.20,  2.37,  3.40,  2.47,  3.60,  2.62,  4.,   2.92,
     D  0.,   0.0/
   8  DATA RROUGH/0.,   1.,   1.,   0.62,  2.,   0.52,  3.,   0.50,  4.,   0.49,
     1  5.,   0.51,  6.,   0.55,  7.,   0.60,  8.,   0.65,  9.,   0.71,
     2  10.   0.77/
   9  DATA VECCVR/0.,   0.,   1.,   0.40, 2.,   0.65, 4.,   1.20, 12.,  2.6,
     1 14.30,  3.,   0.,   0.,   0.,   0.,   0.,   0.,
     2  0.,   0.,   1.,   0.20,  2.,   0.35,  4.,   0.58, 12.,   1.25,
     3 14.30,  1.49, 20.,   2.42,  0.,   0.,   0.,   0.,
     4  0.,   0.,   1.,   2.25,  2.,   4.,   4.,   6.90,  6.,   9.3,
     5  8.,  10.95, 10.,  12.50, 11.75, 14.,   0.,   0.,
     6  0.,   0.,   1.,   2.,   2.,   3.50,  4.,   6.,   6.,   7.8,
     7  8.,   9.30, 10.,  10.75, 12.,  12.,   14.,  13.35,
     8  0.,   0.,   1.,   1.25,  2.,   2.20,  4.,   3.52,  6.,   4.6,
     9 12.80,  8.,   0.,   0.,   0.,   0.,   0.,   0.,
     A  0.,   0.,   1.,   1.,   2.,   1.75,  4.,   2.8,   6.,   3.8,
     B  8.,   4.60, 16.70,  8.,   0.,   0.,   0.,   0.,
     C  0.,   0.,   1.,   1.,   2.,   1.50,  4.,   2.45,  6.,   3.18,
     D  8.,   3.80, 21.10,  8.,   0.,   0.,   0.,   0.,
     E  0.,   0.,   1.,   0.75,  2.,   1.50,  4.,   2.10,  6.,   2.7,
     F  8.,   3.25, 26.50,  8.,   0.,   0.,   0.,   0.,
     G  0.,   0.,   1.,   0.60,  2.,   1.,   4.,   1.75,  6.,   2.25,
     H  8.,   2.75, 12.,   3.75, 32.,   7.85;  0.,   0./
  10  DATA WIND/ 1.,100.,1.20,103.,1.30,104.,1.40,105.,  1.5,108.,
     1  1.8,113.,  2.4,126.,  2.8,140.,  4.5,223.,  10.,670.,
     2  1.,100.,  1.2,102.,  1.3,103.,  1.4,104.,  1.5,106.,
     3  1.8,109.,  2.4,118.,  2.8,125.,  4.5,175.,  10.,365./
  11  DATA SW/0.,0.,10000.,8000.,6000.,4000.,3000.,2000.,1000.,
     1   800.,600.,400.,300.,200.,100.,  80.,  60.,  40.,  30.,  20.,10.,
     2   300.,  52.80,   0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     3  0.,   0.,   0.25,  1.,   2.75,  3.50,  4.90,  6.90,  8.50, 11.,  15.5,
     4   290.,  51.90,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     5  0.,   0.25,  0.75,  1.25,  3.,   3.75,  5.10,  7.,   8.75, 11.5,  16.,
     6   280.,  51.,   0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     7  0.,   0.25,  0.75,  1.50,  3.50,  4.25,  5.80,  7.90,  9.50, 12.,  16.5,
     8   270.,  50.10,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     9  0.,   0.50,  0.80,  1.80,  3.90,  4.70,  6.,   8.10, 10.,  12.5,  17.,
     A   260.,  49.10,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     B  0.,   0.50,  1.,   1.80,  3.70,  4.50,  6.,   8.20, 10.10, 12.8,  17.5,
     C   250.,  45.20,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     D  0.,   0.50,  1.,   2.,   4.,   5.,   6.50,  8.75, 10.60, 13.,  17.6,
     E   240.,  47.20,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     F  0.20,  0.75,  1.10,  2.10,  4.20,  5.20,  7.,   9.,   11.,  13.5,  18.2,
     G   230.,  46.20,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   0.,
     H  0.25,  0.95,  1.50,  2.50,  4.80,  5.90,  7.50,  9.75, 11.50, 14.,  18.6/
  12  DATA SX/  220.,  45.20,  0.,0.,  0.,   0.,   0.,   0.,   0.,0.,
     1  0.50,  1.,   1.60,  2.80,  5.,   6.10,  7.90, 10.,  11.80, 143,  18.8,
     2   210.,  44.20,  0.,  0.,   0.,   0.,   0.,   0.,   0.,   .2,
     3 0.75,  1.50,  2.,   3.30,  5.90,  6.90,  8.20, 10.40, 12.20, 14.5,  18.9,
     4  200.00, 43.20,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.25,
     5  0.8,   1.5,   2.1,   3.4,   6.0,   7.0,   8.75, 10.9,  12.5,  15.,   19.4,
     6 190.0, 42.1,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.50,  0.8,
     7  1.00,  2.00,  2.80,  4.00,  6.10,  7.00,  8.80, 11.00, 12.50, 15.1,  19.75,
     8 180.00, 40.90,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.20,  0.50,
     9  1.00,  1.90,  2.50,  3.90,  6.50,  7.50,  9.20, 11.40, 12.70, 15.8,  20.,
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     A 170.00,39.60, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.25, 0.75,
     B 1.1, 2.0, 3.0, 4.25, 7.0, 8.0, 9.8,11.8,13.0,16.,20.,
     C 160.00,36.50, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.50, 0.9,
     D  1.40, 2.40, 3.10, 4.80, 7.40, 8.50,10.10,12.30,14.00,16.5,20.6,
     E 150.00,37.35, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.50, 0.9,
     F 1.50, 2.50, 3.50, 5.00, 7.75, 8.90,10.50,12.60,14.50,17.,21.,
     G 140.00,36.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.00, 0.75, 1.,
     H 1.80, 2.90, 3.60, 5.20, 8.00, 9.00,10.60,12.90,14.50,17.,21./
  13  DATA SY/130.,35.70, 0., 0., 0., 0., 0., 0., 0.80, 1.,
     1 1.95, 3.00, 3.90, 5.40, 8.00, 9.20,11.00,13.00,14.90,17.3,21.1,
     2 120.00,33.25, 0.00, 0.00, 0.00, 0.00, 0.00, 0.25, 1.10, 1.8,
     3 2.60, 3.80, 4.75, 6.20, 9.60,10.00,11.80,13.80,15.50,17.75,21.5,
     4 110.00,31.80, 0.00, 0.00, 0.00, 0.00, 0.00, 0.30, 1.50, 1.95,
     5 2.90, 4.00, 5.00, 6.75, 9.50,10.,12.30,14.50,16.20,18.6,22.6,
     6 100.00,29.90, 0.00, 0.00, 0.00, 0.00, 0.00, 0.30, 1.50, 2.,
     7 3.00, 4.25, 5.40, 7.00,10.00,11.00,13.00,15.00,16.50,19.2,23.,
     8 90.00,28.10, 0.00, 0.00, 0.00, 0.00, 0.00, 0.50, 1.80,2.25,
     9 3.30, 4.80, 5.90, 7.60,10.60,11.50,13.45,15.75,17.50,19.8,24.,
     A 80.00,16.20, 0.00, 0.00, 0.00, 0.00, 0.20, 0.75, 2.00,2.5,
     B 3.60, 4.90, 6.00, 7.60,10.70,11.90,13.60,16.00,17.50,20.,24.,
     C 70.00,24.00, 0.00, 0.00, 0.00, 0.50, 0.00, 1.00, 2.75, 3.2,
     D 4.00, 5.25, 6.20, 8.00,10.80,12.00,13.75,16.00,18.00,20.5,26.1,
     E 60.00,22.00, 0.00, 0.00, 0.00, 0.25, 0.60, 1.20, 2.90, 3.3,
     F 4.40, 5.70, 6.80, 8.45,11.50,12.70,14.75,17.00,19.00,21.7,26.5,
     G 50.00,19.20, 0.00, 0.00, 0.00, 0.50, 0.90, 1.50, 3.00, 3.75,
     H 4.80, 6.00, 7.10, 9.00,12.40,13.55,15.60,18.00,20.10,23.,28./
  14  DATA SZ/40.,16.80,0.,0.,0.,0.60, 1., 1.90, 3.50, 4.2,
     1 5.20, 6.80, 7.90, 9.80,13.10,14.50,16.50,19.20,21.00,-1.,-1.,
     2 35.00,15.00, 0.00, 0.00, 0.25, 0.80, 1.40, 2.10, 3.95, 4.5,
     3 5.60, 7.00, 8.10,10.10,13.90,15.25,17.40,20.50,-1.00,-1.00,-1.,
     4 30.00,13.50, 0.00, 0.00, 0.25, 0.90, 1.30, 2.20, 4.00, 4.8,
     5 6.00, 7.50, 8.90,11.00,15.00,16.40,19.00,-1.00,-1.00,-1.,-1.,
     6 25.00,11.80, 0.00, 0.00, 0.40, 1.00, 1.80, 2.50, 4.50, 5.3,
     7 6.75, 8.25, 9.90,12.00,16.00,-1.00,-1.00,-1.00,-1.00,-1.,-1.,
     8 20.00, 9.20, 0.00, 0.00, 0.50, 1.00, 1.80, 2.50, 5.00, 5.8,
     9 7.10, 9.10,10.00,13.80,-1.00,-1.00,-1.00,-1.00,-1.00,-1.,-1.,
     A 15.00, 6.95, 0.00, 0.25, 0.75, 1.20, 2.00, 3.25, 5.50, 6.5,
     B 8.00,10.10,12.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.,-1.,
     C 10.00, 3.50, 0.00, 0.25, 0.50, 1.50, 2.00, 3.10, 5.75, 6.8,
     D 8.60,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.,-1.,
     E 5.00, 0.00, 0.00, 0.60, 1.00, 2.00, 2.75, 3.75, 6.00,-1.,
     G -1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.00,-1.,-1./
  15  DATA SCALE/0.,3.5,7.1,11.8,15.2,18.5,20.8,23.2,24.75,26.47,
     1 28.20,30.80,33.50,35.50,37.70,39.50,41.25,43.20,44.75,46.12,
     2 47.50,49.00,50.00,51.25,52.30,53.60,54.50,55.50,56.50,57.5,
     3 58.50,59.50,60.50,61.50,62.40,63.20,64.00,65.50,66.90,67.15,
     4 69.40,70.60,71.80,73.00, 0.50, 1.00, 2.00, 5.00,10.00,15.,
     5 20.00,25.00,30.00,35.00,40.00,50.00,60.00,70.00,80.00,90.,
     6 100.,110.,120.,130.,140.,150.,160.,170.,180.,190.,
     7 200.,210.,220.,230.,240.,250.,260.,270.,280.,290.,
     8 300.,320.,340.,360.,380.,400.,420.,440./
  16  END
```

SINGLY REFERENCED VARIABLES

COMMON - 2F DIMENS - 3F VARI - 2CN

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATA | - | 6F | 7F | 8F | 9F | 10F | 11F | 12F | 13F | 14F | 15F |
| EQUIVA | - | 4F | 5F | | | | | | | | |
| EROD | ()R | 2CO | 6DA | | | | | | | | |
| RROUGH | ()R | 2CO | 8DA | | | | | | | | |
| SCALE | ()R | 2CO | 15DA | | | | | | | | |
| SOLLSS | ()R | 2CO | 4EQ | 4EQ | 5EQ | 5EQ | | | | | |
| SW | ()R | 3DI | 4EQ | 11DA | | | | | | | |
| SX | ()R | 3DI | 4EQ | 12DA | | | | | | | |
| SY | ()R | 3DI | 5EQ | 13DA | | | | | | | |
| SZ | ()R | 3DI | 5EQ | 14DA | | | | | | | |
| VECCVR | ()R | 2CO | 9DA | | | | | | | | |
| WIND | ()R | 2CO | 10DA | | | | | | | | |
| WNDERN | ()R | 2CO | 7DA | | | | | | | | |

```
      SUBROUTINE COMPUT
C
C*ABSTRACT: Computes the amount of soil loss.
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*CALLED BY:
C         EROSIO
C
C*CALLS TO:
C          IPRIME, KPRIME, LPRIME, FLRM, VEC, FIN
C
C*COMMON BLOCKS:
CNAME       VAR
C            ck5, ck8, ck11, ck13, *ans
CNAME       VAR2
C            cfct
C
C*TECHNICAL DESCRIPTION:
C             Directs the calls to other routines based on the users
C             input to calculate the amount of soil loss.
C
      COMMON/VAR/ PAG84,KLSP,RDCHT,RDGSP,RDGRCH,ANG,WNDFRC,HTBR,
     1FW,R,A,CK5,CK6,CK8,CK9,CK11,
     X CK13,CK1,CK2,CK3,CK4,ANS,SAIR,NU,FL,ANGL,MAT
      COMMON/VAR2/CFCT,U(10),HT,RHO
      REAL MAXTIM,KLSP,MAP,MAT
      CALL IPRIME (PAG84,KLSP,CK1,CK2,PI)
      CALL KPRIME (RDCHT,RDGSP,RDGRCH,CK3,CK4,PK)
      E2=PI*PK/100.
      E3=E2*CFCT
      IF(E3.LT.1.E-10) GO TO 10
      CALL LPRIME(ANG,WNDFRC,HTBR,FW,PL)
      CALL FLRM(PL,E2,E3,E4)
      IF (CK5.GT.0.)  CALL VEC(1,CK6,DUM,R,ANS)
      IF (CK8.GT.0.) CALL VEC(2,CK9,DUM,R,ANS)
      IF (CK11.GT.0.) CALL VEC(3,DUM,DUM,R,ANS)
      V=ANS
      IF(CK13 .LE.0. ) GO TO 5
      CALL VEC(4,DUM,A,R,V)
    5 IF(V.GT. 18000.) GO TO 7
      CALL FIN(E4,V,ANS)
      RETURN
    7 V=18000.
      CALL FIN(E4,V,ANS)
      RETURN
   10 ANS=0.
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ANGL | -R | 2C0 | FLRM | - | 11SU | KPRIME | - | 6SU | MAXTIM | -R | 4RL | RHO | -R | 3C0 | VAR | - | 2CN | | | | | | |
| COMPUT | - | 1SU | HT | -R | 3C0 | LPRIME | - | 10SU | NU | -I | 2C0 | SAIR | -R | 2C0 | VAR2 | - | 3CN | | | | | | |
| FL | -R | 2C0 | IPRIME | - | 5SU | MAP | -R | 4RL | REAL | - | 4F | U | (R | 3C0 | | | | | | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 2C0 | 17AC | | | | | | | | | | | | | | | | | | | | |
| ANG | -R | 2C0 | 10AC | | | | | | | | | | | | | | | | | | | | |
| ANS | -R | 2C0 | 12AC | 13AC | 14AC | 15 | 19AC | 22AC | 24= | | | | | | | | | | | | | | |
| CALL | - | 5F | 6F | 10F | 11F | 12F | 13F | 14F | 17F | 19F | 22F | | | | | | | | | | | | |
| CFCT | -R | 3C0 | 8 | | | | | | | | | | | | | | | | | | | | |
| CK1 | -R | 2C0 | 5AC | | | | | | | | | | | | | | | | | | | | |
| CK11 | -R | 2C0 | 14 | | | | | | | | | | | | | | | | | | | | |
| CK13 | -R | 2C0 | 16 | | | | | | | | | | | | | | | | | | | | |
| CK2 | -R | 2C0 | 5AC | | | | | | | | | | | | | | | | | | | | |
| CK3 | -R | 2C0 | 6AC | | | | | | | | | | | | | | | | | | | | |
| CK4 | -R | 2C0 | 6AC | | | | | | | | | | | | | | | | | | | | |
| CK5 | -R | 2C0 | 12 | | | | | | | | | | | | | | | | | | | | |
| CK6 | -R | 2C0 | 12AC | | | | | | | | | | | | | | | | | | | | |
| CK8 | -R | 2C0 | 13 | | | | | | | | | | | | | | | | | | | | |
| CK9 | -R | 2C0 | 13AC | | | | | | | | | | | | | | | | | | | | |
| COMMON | - | 2F | 3F | | | | | | | | | | | | | | | | | | | | |
| DUM | -R | 12AC | 13AC | 14AC | 14AC | 17AC | | | | | | | | | | | | | | | | | |
| E2 | -R | 7= | 8 | 11AC | | | | | | | | | | | | | | | | | | | |
| E3 | -R | 8= | 9 | 11AC | | | | | | | | | | | | | | | | | | | |
| E4 | -R | 11AC | 19AC | 22AC | | | | | | | | | | | | | | | | | | | |
| FIN | - | 19SU | 22SU | | | | | | | | | | | | | | | | | | | | |
| FW | -R | 2C0 | 10AC | | | | | | | | | | | | | | | | | | | | |
| HTBR | -R | 2C0 | 10AC | | | | | | | | | | | | | | | | | | | | |
| IF | - | 9F | 12F | 13F | 14F | 16F | 18F | | | | | | | | | | | | | | | | |
| KLSP | -R | 2C0 | 4RL | 5AC | | | | | | | | | | | | | | | | | | | |
| MAT | -R | 2C0 | 4RL | | | | | | | | | | | | | | | | | | | | |
| PAGE4 | -R | 2C0 | 5AC | | | | | | | | | | | | | | | | | | | | |
| PI | -R | 5AC | 7 | | | | | | | | | | | | | | | | | | | | |
| PK | -R | 6AC | 7 | | | | | | | | | | | | | | | | | | | | |
| PL | -R | 10AC | 11AC | | | | | | | | | | | | | | | | | | | | |
| R | -R | 2C0 | 12AC | 13AC | 14AC | 17AC | | | | | | | | | | | | | | | | | |
| RDCHT | -R | 2C0 | 6AC | | | | | | | | | | | | | | | | | | | | |
| RDCRCH | -R | 2C0 | 6AC | | | | | | | | | | | | | | | | | | | | |
| RDCSP | -R | 2C0 | 6AC | | | | | | | | | | | | | | | | | | | | |
| RETURN | - | 20F | 23F | 25F | | | | | | | | | | | | | | | | | | | |
| V | -R | 15= | 17AC | 18 | 19AC | 21= | 22AC | | | | | | | | | | | | | | | | |
| VEC | - | 12SU | 13SU | 14SU | 17SU | | | | | | | | | | | | | | | | | | |
| WNDFRC | -R | 2C0 | 10AC | | | | | | | | | | | | | | | | | | | | |
| 5 | - | 16 | 18* | | | | | | | | | | | | | | | | | | | | |
| 7 | - | 18 | 21* | | | | | | | | | | | | | | | | | | | | |
| 10 | - | 9 | 24* | | | | | | | | | | | | | | | | | | | | |

```
      1       SUBROUTINE LPRIME(ANG,WNDFRC,HTBR,FW,PL)
              C
              C*ABSTRACT: Calculates the percentage of soil loss due to the wind force.
              C
              C*AUTHOR:
              C
              C*TYPE: NUMERICAL ANALYSIS
              C
              C*CALLED BY:
              C          COMPUT
              C
              C*CALLS TO:
              C          INTER
              C
              C*COMMON BLOCKS:
              CNAME       VAR1
              C            wndern
              C
              C*TECHNICAL DESCRIPTION:
              C            Calculates the percentage of soil loss due to the wind
              C            as a function of the wind force and angle to the trench.
              C
      2             COMMON/VAR1/WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),WNDERN(2,11,6),
                   1 SOILSS(21,35),SCALE(44,2),VEGCVR(2,9,9)
      3             IF (FW.EQ.0..OR.FW.GE.5000.) FW=5000.
      4             DO 1 I=1,6
      5               A=I
      6             IF (ANG.GT.(A-1)*10.) GO TO 1
      7             IF (ANG.EQ.(A-1)*10.) GO TO 2
      8             GO TO 4
      9           1 CONTINUE
     10             ANG=50.
     11             I=6
     12           2 CALL INTER(WNDERN,I,WNDFRC,PK50,1,11,6)
     13             GO TO 5
     14           4 CALL INTER(WNDERN,I-1,WNDFRC,PK1,1,11,6)
     15             CALL INTER(WNDERN,I,WNDFRC,PK2,1, 11,6)
     16             PK50=(PK2-PK1)*ANG/(10.*I)+PK1
     17           5 S=PK50*FW
     18             PL=S-10.*HTBR
     19             RETURN
     20             END
```

SINGLY REFERENCED VARIABLES

| | | | | | |
|---|---|---|---|---|---|
| COMMON - | 2F | LPRIME - | 1SU | RROUGH( )R | 2CO |
| EROD ( )R | 2CO | RETURN - | 19F | SCALE( )R | 2CO |
| SOLLSS( )R | 2CO | VEGCVR( )R | 2CO | VARI - | 2CN |
| WIND ( )R | 2CO | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | -R | 5= | 6 | 7 | | | |
| ANG | -R | 1AC | 6 | 7 | 10= | 16 | |
| CALL | - | 12F | 14F | 15F | | | |
| FW | -R | 1AC | 3 | 3 | 3= | 17 | |
| HTBR | -R | 1AC | 18 | | | | |
| I | -I | 4DO | 5 | 11= | 12AC | 14AC | 15AC 16 |
| IF | - | 3F | 6F | 7F | | | |
| INTER | - | 12SU | 14SU | 15SU | | | |
| PK1 | -R | 14AC | 16 | 16 | | | |
| PK2 | -R | 15AC | 16 | | | | |
| PK50 | -R | 12AC | 16= | 17 | | | |
| PL | -R | 1AC | 18= | | | | |
| S | -R | 17= | 18 | | | | |
| WNDERN( )R | | 2CO | 12AC | 14AC | 15AC | | |
| WNDFRC | -R | 1AC | 12AC | 14AC | 15AC | | |
| 1 | - | 4DO | 6 | 9* | | | |
| 2 | - | 7 | 12* | | | | |
| 4 | - | 8 | 14* | | | | |
| 5 | - | 13 | 17* | | | | |

```
      1          SUBROUTINE IPRIME(PAC84 ,KLSP,CK1,CK2,PI)
                 C
                 C*ABSTRACT: Calculate percentage of soil loss due to windward knoll slope.
                 C
                 C*AUTHOR:
                 C
                 C*TYPE: NUMERICAL ANALYSIS
                 C
                 C*CALLED BY:
                 C          COMPUT
                 C
                 C*CALLS TO:
                 C          INTER
                 C
                 C*COMMON BLOCKS:
                 CNAME      VAR1
                 C           wind
                 C
                 C*TECHNICAL DESCRIPTION:
                 C            Calculate the percentage of soil loss as a function
                 C            of dry soil fraction greater than 84 mm. and the knollslope
                 C            percent.
                 C
      2                COMMON/VAR1/WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),WNDERN(2,11,6),
                      1 SOILSS(21,35),SCALE(44,2),VEGCVR(2,9,9)
      3                REAL MAXTIM,KLSP
      4                IF (PAC84.GT.0. .AND. PAC84 .LT.81.) GO TO 1
      5                IF(PAC84.LE.0.) PAC84=1.
      6                IF(PAC84.GE.81.) PAC84=80.
      7              1 M=PAC84
      8                INIT=M-10*(M/10)+1
      9                IRNS=M/10+1
     10                TA=EROD(IRNS,INIT)
     11                IF (KLSP .GT. 0. .AND. CK1 .GT. 0. .OR. CK2 .GT. 0.) GO TO 3
     12                SI=100.
     13                GO TO 4
     14              3 I=1
     15                S=KLSP
     16                IF(CK2.GT.0.) I=2
     17                CALL INTER(WIND,1,S,SI,1,10,2)
     18              4 PI=SI*TA
     19                RETURN
     20                END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALL | - | 17F | INTER | - | 17SU | MAXTIM | -R | 3RL | RETURN | - | 19F |
| COMMON | - | 2F | IPRIME | - | 1SU | REAL | - | 3F | RROUGH | ()R | 2CO |
| SCALE | ()R | 2CO | VAR1 | - | 2CN | WNDERN | ()R | 2CO | | | |
| SOLLSS | ()R | 2CO | VEGCVR | ()R | 2CO | | | | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CK1 | -R | 1AC | 11 | | | | | | | | |
| CK2 | -R | 1AC | 11 | 16 | | | | | | | |
| EROD | ()R | 2CO | 10 | | | | | | | | |
| I | -I | 14= | 16= | 17AC | | | | | | | |
| IF | - | 4F | 5F | 6F | 11F | 16F | | | | | |
| INIT | -I | 8= | 10 | | | | | | | | |
| IRNS | -I | 9= | 10 | | | | | | | | |
| KLSP | -R | 1AC | 3RL | 11 | 15 | | | | | | |
| M | -I | 7= | 8 | 8 | 9 | | | | | | |
| PAC84 | -R | 1AC | 4 | 5 | 5= | 6 | 6= | 7 | | | |
| PI | -R | 1AC | 18= | | | | | | | | |
| S | -R | 15= | 17AC | | | | | | | | |
| SI | -R | 12= | 17AC | 18 | | | | | | | |
| TA | -R | 10= | 18 | | | | | | | | |
| WIND | ()R | 2CO | 17AC | | | | | | | | |
| 1 | - | 4 | 7* | | | | | | | | |
| 3 | - | 11 | 14* | | | | | | | | |
| 4 | - | 13 | 18* | | | | | | | | |

```
      SUBROUTINE KPRIME(RDGHT,RDGSP,RDGRGH,CK3,CK4,PK)
C
C*ABSTRACT: Calculate the soil ridge roughness factor as a function
C           of the soil ridge roughness.
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*CALLED BY:
C         COMPUT
C
C*CALLS TO:
C          INTER
C
C*COMMON BLOCKS::
CNAME      VAR1
C            rrough
C
C*TECHNICAL DESCRIPTION:
C             Calculate the soil ridge roughness factor (between 0 and 1.)
C             as a function of the soil ridge roughness.
C
      COMMON/VAR1/WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),WNDERW(2,11,6),
     1 SOILSS(21,35),SCALE(44,2),VEGCVR(2,9,9)
      IF (RDGRGH .GT. 0.) GO TO 1
      IF (RDGHT.GT.0. .AND. RDGSP.GT.0.) GO TO 2
      IF (CK3.GT.0.) GO TO 3
      IF (CK4.GT.0.) GO TO 4
      PK=1.
      RETURN
    1 CALL INTER(RROUGH,1,RDGRGH,PK,1,11,1)
      RETURN
    2 RDGRGH=4.*RDGHT**2/RDGSP
      GO TO 1
    3 PK = 1.
      RETURN
    4 PK=.5
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CALL - | 9F | EROD ()R | 2CO | KPRIME - | 1SU | SOLLSS()R | 2CO | VEGCVR()R | 2CO | WNDERN()R | 2CO |
| COMMON - | 2F | INTER - | 9SU | SCALE ()R | 2CO | VAR1 - | 2CN | WIND ()R | 2CO | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | |
|---|---|---|---|---|---|---|
| CK3 | -R | 1AC | 8 | | | |
| CK4 | -R | 1AC | 6 | | | |
| IF | - | 3F | 4F | 5F | 6F | |
| PK | -R | 1AC | 7= | 9AC | 13= | 15= |
| RDCHT | -R | 1AC | 4 | 11 | | |
| RDGRCH | -R | 1AC | 3 | 9AC | 11= | |
| RDGSP | -R | 1AC | 4 | 11 | | |
| RETURN | - | 8F | 10F | 14F | 16F | |
| RROUGH ()R | | 2CO | 9AC | | | |
| 1 | - | 3 | 9* | 12 | | |
| 2 | - | 4 | 11* | | | |
| 3 | - | 5 | 13* | | | |
| 4 | - | 6 | 15* | | | |

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```
                    SUBROUTINE FLRM (PL,E2,E3,E4)
      1       SUBROUTINE FLRM (PL,E2,E3,E4)
C
C*ABSTRACT: Calculate E4 from E2, E3, and PL.
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       PL - Percentage of soil loss due to the wind force.
CIN       E2 - Percentage of soil loss as a function of dry soil, knoll slope
C              percent, and the ridge roughness factor.
CIN       E3 - Climatic factor times E2.
COUT      E4 - Soil loss based on PL, E2, and E3.
C
C*CALLED BY:
C          COMPUT
C
C*CALLS TO:
C          NONE
C
C*COMMON BLOCKS:
CNAME       VAR1
C             sollss, scale
C
C*TECHNICAL DESCRIPTION:
C             The calculation of the variable E4 based on PL from LPRIME,
C             E2 (a function of PK from KPRIME and PI from IPRIME), and
C             E3.  Will use E4 combined with the vegetative cover in FIN to
C             calculate the final soil loss.
C
      2       COMMON/VAR1/WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),WNDERN(2,11,6),
             1 SOLLSS(21,35),SCALE(44,2),VEGCVR(2,9,9)
      3       COMMON/VAR2/CFCT,U(10),HT,RHO
      4       J=0
      5       VH1=0
      6       VH2=0
      7       DO 1 I=2,35
      8       IF (E2.LT. SOLLSS(1,I)) GO TO 1
      9       IF (E2.EQ.SOLLSS(1,I)) GO TO 2
     10       GO TO 3
     11     1 CONTINUE
     12       E2=SOLLSS(1,35)
     13       E3=E2*CFCT
     14       I=35
     15       GO TO 2
     16     3 IABOVE=I
     17       IBELOW=I-1
     18       GO TO 5
     19     2 IABOVE=I
     20       IBELOW=I
     21       J=2
     22     5 DO 6 I=3,21
     23       IF (PL.LT.SOLLSS(1,I)) GO TO 6
     24       IF (PL.EQ.SOLLSS(1,I)) GO TO 7
     25       GO TO 8
     26     6 CONTINUE
     27       PL=SOLLSS(21,1)
```

```
      I=21
      GO TO 7
    8 IFRNT=I
      IBHND=I-1
      IF ( J .NE. 2 ) GO TO 10
      P1=SOLLSS(IBHND,IABOVE)
      P2=SOLLSS(IFRNT,IABOVE)
      DST=P1+(P2-P1)*(SOLLSS(IBHND,1)-PL)/(SOLLSS(IBHND,1)-
     1SOLLSS(IFRNT,1) )
      GO TO 17
    7 IFRNT=I
      IBHND=I
      IF( J.NE. 2) GO TO 18
      DST=SOLLSS(IBHND,IBAOVE)
      GO TO 17
   18 P1=SOLLSS(IFRNT,IABOVE)
      P2=SOLLSS(IFRNT,IBELOW)
      DST= P2-(P2-P1)*(E2-SOLLSS(1,IBELOW))/(SOLLSS(1,IABOVE)-
     1 SOLLSS(1,IBELOW))
      GO TO 17
   10 P1=SOLLSS(IBHND,IBAOVE)
      P2=SOLLSS(IBHND,IBELOW)
      P3=SOLLSS(IFRNT,IABOVE)
      P4=SOLLSS(IFRNT,IBELOW)
      VH1=P2-(P2-P4)*(SOLLSS(IBHND,1)-PL)/(SOLLSS(IBHND,1)-SOLLSS(IFRNT,
     1 1) )
      VH2=P1-(P1-P3)*(SOLLSS(IBHND,1)-PL)/(SOLLSS(IBHND,1)-SOLLSS(IFRNT,
     1 1) )
      DST=VH1-(VH1-VH2)*(SOLLSS(1,IBELOW)-E2)/(SOLLSS(1,IBELOW)-SOLL
     1 SS(1,IABOVE) )
   17 L=2
      M=1
   15 DO 11 I=1,44
      IF (E3 .GT.SCALE(I,L)) GO TO 11
      IF (E3 .EQ. SCALE(I,L)) GO TO 12
      GO TO 13
   11 CONTINUE
      E3=SCALE(44,L)
      I=44
      GO TO 12
   13 IF(I.EQ.1) GO TO 12
      DST=SCALE(I-1,M)+(E3-SCALE(I-1,L))*(SCALE(I,M)-SCALE(I-1,M))/
     1 (SCALE(I,L)-SCALE(I-1,L)) -DST
      IF (L.EQ.1) GO TO 14
   16 L=1
      M=2
      TE3=E3
      E3=DST
      DST=0.
      GO TO 15
   12 DST=SCALE(I,M)-DST
      IF(L .EQ. 1) GO TO 14
      GO TO 16
   14 E4=DST
      E3=TE3
      RETURN
      END
```



READER FICHE

SINGLY REFERENCED VARIABLES

| | | |

```
      SUBROUTINE VEG(I,A,B,R,E)
C
C*ABSTRACT: Vegetative cover calculation.
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       I - Parameter which dictates what type of vegetative cover there is.
CIN       A - If looking at flat anchord small grain stubble, will then
C             look at flat or standing(0,1). If small grain crops, will
C             then decide if in furrow or on smooth ground.  Otherwise this
C             variable is not used.
CIN       B - Height of standing flat grain.
CIN       R - Equivalent vegetative cover (lbs/acre)
COUT      E - Vegetative cover (lbs/acre)
C
C*CALLED BY:
C          COMPUT
C
C*CALLS TO:
C          INTER
C
C*COMMON BLOCKS:
CNAME       VAR1
C             vegcvr
C
C*TECHNICAL DESCRIPTION:
C             The calculation of the vegetative cover in lbs/acre.
C
      COMMON/VAR1/WIND(2,10,2),EROD(9,10),RROUGH(2,11,1),WNDERN(2,11,6),
     1 SOILSS(21,35),SCALE(44,2),VEGCVR(2,9,9)
      R=R/1000.
      GO TO (1,2,3,4),I
    1 J=2
      IF (A.GT.0.) J=1
    5 CALL INTER(VEGCVR,J,R,ANS,2,11,9)
      E=ANS*1000.
      R=R*1000.
      IF(J .EQ.4 .OR. J .EQ. 3) R=R/10.
        RETURN
    2 J=4
      R=R*10.
      IF (A.GT.0.) J=3
      GO TO 5
    3 J=5
       GO TO 5
    4 IF(B-8.) 20,8,9
    9 IF (B-12.)10,11,12
   12 IF (B-16.) 13,14,15
   15 IF (B-20.)16,17,7
    7   R=20.
       GO TO 17
    8 J=6
      GO TO 5
   11 J=7
      GO TO 5
```

```
      14 J=8
         GO TO 5
      17 J=9
         GO TO 5
      19 CALL INTER( VEGCVR, I,R,A1,2,11,9)
         CALL INTER( VEGCVR, I+1,R,C,2,11,9)
         L=B
         X=B-L
         E=(A1-C)*X+C
         E=E*1000.
         R=R*1000.
         RETURN
      10 I=6
         GO TO 19
      13 I=7
         GO TO 19
      16 I=8
         GO TO 19
      20 I=5
         GO TO 19
         END
```

SINGLY REFERENCED VARIABLES

| | | |

```
      SUBROUTINE INTER(A,N,Z,ANS,I,M,M3)
C
C*ABSTRACT: Interpolating routine
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTIONS:
CIN       A - Array that is being used to calculate ANS.
CIN       N - Which curve in array a to be used.
CIN       Z - Value to be looked for on the curve.
COUT      ANS - Corresponding point to Z on curve N of array A.
CIN       I - Dictates which direction to look on the curve. ie x-y or y-x.
CIN       M - Number of points on each curve in array A.
CIN       M3 - Number of curves in array A.
C
C*CALLED BY:
C          LPRIME, IPRIME, KPRIME, VEC
C
C*CALLS TO:
C          NONE
C
C*TECHNICAL DESCRIPTION:
C             Interpolates looking for ANS from Z in array A using curve N.
C
      DIMENSION A(2,M,M3)
      IF (I.EQ.1) K=2
      IF (I.EQ.2) K=1
      J=0
      MM=M-1
      DO 5 L=1,MM
      J=J+1
      CHEC1=A(1,J,N)
      IF (ABS(CHEC1-Z) .LT. .001) GO TO 9
      CHEC2=A(1,J+1,N)
      IF (CHEC2.EQ. 0) GO TO 18
      IF (ABS(CHEC2-Z) .LT. .001) GO TO 10
      IF (CHEC1.GT.Z) GO TO 6
      IF (CHEC2.GT.Z) GO TO 8
      GO TO 5
    6 IF (CHEC2.LT.Z) GO TO 8
    5 CONTINUE
   18 Z=CHEC1
    9 ANS=A(K,J,N)
      RETURN
   10 ANS=A(K,J+1,N)
      RETURN
    8 R =(Z-CHEC1)/(CHEC2-CHEC1)
      ANS=A(K,J,N) + R*(A(K,J+1,N)-A(K,J,N))
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

DIMENS - 2F INTER - ISU L -I 7DO

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| A | ()R | 1AC | 2DI | 9 | 11 | 20 | 22 | 25 | 25 | 25 |
| ABS | - | 10SU | 13SU | | | | | | | |
| ANS | -R | 1AC | 20= | 22= | 25= | | | | | |
| CHEC1 | -R | 9= | 10 | 14 | 19 | 24 | 24 | | | |
| CHEC2 | -R | 11= | 12 | 13 | 15 | 17 | 24 | | | |
| I | -I | 1AC | 3 | 4 | 9 | 11 | | | | |
| IF | - | 3F | 4F | 10F | 12F | 13F | 14F | 15F | 17F | |
| J | -I | 5= | 8= | 8 | 9 | 11 | 20 | 22 | 25 | 25 |
| K | -I | 3= | 4= | 20 | 22 | 25 | 25 | 25 | | |
| M | -I | 1AC | 2DI | 6 | | | | | | |
| M3 | -I | 1AC | 2DI | | | | | | | |
| MM | -I | 6= | 7DO | | | | | | | |
| N | -I | 1AC | 9 | 11 | 20 | 22 | 25 | 25 | 25 | |
| R | -R | 24= | 25 | | | | | | | |
| RETURN | - | 21F | 23F | 26F | | | | | | |
| Z | -R | 1AC | 10 | 13 | 14 | 15 | 17 | 19= | 24 | |
| 5 | - | 7DO | 16 | 18* | | | | | | |
| 6 | - | 14 | 17* | | | | | | | |
| 8 | - | 15 | 17 | 24* | | | | | | |
| 9 | - | 10 | 20* | | | | | | | |
| 10 | - | 13 | 22* | | | | | | | |
| 18 | - | 12 | 19* | | | | | | | |

```
      SUBROUTINE FIN(E4,V,ANS)
C
C*ABSTRACT: Final calculation of soil loss.
C
C*AUTHOR:
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       E4 - Soil loss as calculated in FLRM.
CIN       V - Vegetative ground cover in lbs/acre.
COUT      ANS - Soil loss in tons/acre/year.
C
C*CALLED BY:
C          COMPUT
C
C*CALLS TO:
C          NONE
C
C*TECHNICAL DESCRIPTION:
C             Final calculation of soil loss in tons/acre/year as a
C             function of erosion and vegetative cover.
C
        INTEGER V1,V2,VT
      DIMENSION TANN(19), CROSS(19)
      DATA CROSS/-.30103,.02,.3125,.6042,.9166,1.125,1.301,1.4771,
     1 1.5833,1.699,1.8125,1.9031,1.9792,2.1666,2.1761,2.2708,
     2 2.3333,2.3958,2.4375/
      DATA TANN/1.,1.1,1.23,1.37,1.6,1.81,1.97,2.22,2.4,2.6,2.9,3.16,
     1 3.45,3.84,3.9,4.28,4.8,4.9,5./
      V = V/1000.
      VT=V
      IF(V-VT)11,10,11
   10 I=V
      I=I+1
      IF(E4.LE.0.0) GO TO 15
      X=ALOG10(E4)
      Y=CROSS(I)
      Z=X-Y
      IF(Z) 15,99,6
   99 ANS=.5
      RETURN
    6 Z=Z*TANN(I)
      Z=Z-.3010
      ANS=10.**Z
      RETURN
   11 I=V
      V1=I+1.0
      V2=I+2.0
      IF(E4.LE.0.0) GO TO 15
      X1=ALOG10(E4)
      Y1=CROSS(V1)
      Z1=X1-Y1
      IF (Z1) 15,15,16
   16 Z1=Z1*TANN(V1)
      Z1=Z1-.3010
      Z1=10.**Z1
      IF(E4.LE.0.0) GO TO 25
```

```
      X2=ALOG10(E4)
      Y2=CROSS(V2)
      Z2=X2-Y2
      IF(Z2) 25,25,26
   26 Z2=Z2*TANH(V2)
      Z2=Z2-.3010
      Z2=10.**Z2
      GO TO 28
   25 Z2=.5
   28 Z=Z1-Z2
      V1=(V1-1)*1000.
      V2=(V2-1)*1000.
      V=V*1000.
      A=(V-V1)/(1000.)
      ANS=Z1-A*Z
      RETURN
   15 ANS=0.
      RETURN
       END
```

SINGLY REFERENCED VARIABLES

DIMENS - 3F FIN - 1SU INTEGE - 2F

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 47= | 48 | | | | | | | | |
| ALOG10 | - | 12SU | 26SU | 34SU | | | | | | | |
| ANS | -R | 1AC | 16= | 20= | 48= | 50= | | | | | |
| CROSS | ()R | 3D1 | 4DA | 13 | 27 | 35 | | | | | |
| DATA | - | 4F | 5F | | | | | | | | |
| E4 | -R | 1AC | 11 | 12 | 25 | 26 | 33 | 34 | | | |
| I | -I | 9= | 10= | 10 | 13 | 18 | 22= | 23 | 24 | | |
| IF | - | 8F | 11F | 15F | 25F | 29F | 33F | 37F | | | |
| RETURN | - | 17F | 21F | 49F | 51F | | | | | | |
| TANH | ()R | 3D1 | 5DA | 18 | 30 | 38 | | | | | |
| V | -R | 1AC | 6= | 6 | 7 | 8 | 9 | 22 | 46= | 46 | 47 |
| V1 | -I | 2IN | 23= | 27 | 30 | 44= | 44 | 47 | | | |
| V2 | -I | 2IN | 24= | 35 | 38 | 45= | 45 | | | | |
| VT | -I | 2IN | 7= | 8 | | | | | | | |
| X | -R | 12= | 14 | | | | | | | | |
| X1 | -R | 26= | 28 | | | | | | | | |
| X2 | -R | 34= | 36 | | | | | | | | |
| Y | -R | 13= | 14 | | | | | | | | |
| Y1 | -R | 27= | 28 | | | | | | | | |
| Y2 | -R | 35= | 36 | | | | | | | | |
| Z | -R | 14= | 15 | 18= | 18 | 19= | 19 | 20 | 43= | 48 | |
| Z1 | -R | 28= | 29 | 30= | 30 | 31= | 31 | 32= | 32 | 43 | 48 |
| Z2 | -R | 36= | 37 | 38= | 38 | 39= | 39 | 40= | 40 | 42= | 43 |
| 6 | - | 15 | 18* | | | | | | | | |
| 10 | - | 8 | 9* | | | | | | | | |
| 11 | - | 8 | 8 | 22* | | | | | | | |
| 15 | - | 11 | 15 | 25 | 29 | 29 | 50* | | | | |
| 16 | - | 29 | 30* | | | | | | | | |
| 25 | - | 33 | 37 | 37 | 42* | | | | | | |
| 26 | - | 37 | 38* | | | | | | | | |
| 28 | - | 41 | 43* | | | | | | | | |
| 99 | - | 15 | 16* | | | | | | | | |

```
      SUBROUTINE ATMOS
C
C*ABSTRACT: Calculates the atmospheric transport of radionuclides
C           by the gaussian plume model.
C
C*AUTHOR: J STODDARD
C
C*TYPE: NUMERICAL ANALYSIS
C
C*CALLED BY:
C         EXEC
C
C*CALLS TO:
C         DINT, SIGMAZ, EXPF
C
C*COMMON BLOCKS:
CNAME      HYDRA
C           ni
CNAME      FDATA
C           ci, vd, maxind
CNAME      VAR2
C           u
CNAME      VAR
C           nu
CNAME      ATMO1
C           us, ks, *nss, f, fr, rf, ar, rm, sh, sq
C
CNAME      ATMO2
C           *gc, *ac
C
C*TECHNICAL DESCRIPTION:
C            This subroutine takes the amount of nuclides in the
C            atmosphere and calculates the cumulated ground deposition
C            and time integrated air concentration for each nuclide.
C          VARIABLE DESCRIPTIONS:
C            CC - Cumulated ground deposition (curies/meters**2)
C            AC - Time integrated air concentration (curies-sec/meters**3)
C            NSS - Number of stability categories.
C
      LOGICAL MAXIND
      REAL KLSP,MAT
      COMMON/HYDRA/K,ND,IN,NI,DELW,RAIN,DRY,TIMWET,TIMDRY,DD(60),
     1 P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,CONCOF(60),
     2 DRSTY(60),XD(45,60),SOLFAC(45),ORICNT(45),CUMT,IPASS
      COMMON/FDATA/CI(45),VD(45),WC(45),MAXIND
      COMMON/VAR2/CFCT,U(10)
      COMMON/VAR/ PAC84,KLSP,RDCHT,RDCSP,RDCRCH,ANC,WNDFRC,
     1 BTBR,FW,R,A,CK5,CK6,CK8,CK9,CK11,CK13,CK1,CK2,CK3,CK4,ANS,
     2 SAIR,NU,FL,ANGL,MAT,ANGWND,ICALL
      COMMON/ATMO1/HS,KS,NSS,F(10,7),FR,RF,AR,RM(20),
     1 SH,SQ,AREA(20)
      COMMON/ATMO2/CC(45,20),AC(45,20)
C
C     CALLS SIGMAZ, DINT, EXPF
C
      DIMENSION H(10),AY(7)
C     NUMBER OF WIND DIRECTIONS ND
      DATA ND/1/,AY/0.3658,.2751,.2089,.1471,.1046,.0722,.0498/
```

```
      C     STATEMENT FUNCTION FOR PLUME WIDTH STANDARD DEVIATION
   12       SIGMAY(X,I) = AY(I)*X**0.9031
      C
      C
      C     CALCULATE PLUME RISE - EFFECTIVE RELEASE HEIGHT H
   13       DUM = SQ*SH*SH
   14       IF (DUM.GT.0.) DUM = DUM**.333333
   15       DO 5 L = 1,NU
   16       H(L) = SH
   17       IF (U(L).GT.0.) H(L) = SH + DUM/U(L)
   18     5 CONTINUE
      C     FIND VALUE OF FIRST NON-ZERO DRY DEPOSITION COEFFICIENT
   19       DO 15 I = 1,NI
   20       IF (VD(I).LE.0.) GO TO 15
   21       VD1 = VD(I)
   22       GO TO 20
   23    15 CONTINUE
   24       VD1 = 0.01
   25    20 CONTINUE
      C     CALCULATE RAINOUT COEFFICIENT
   26       RC = 0.
   27       IF (RF*FR.GT.0.) RC = 2.53E-5*(RF/FR)**0.85
      C
   28       IF (KS) 25,25,30
      C     LIMITS FOR ANNUAL AVERAGE CONDITIONS
   29    25 NSS = NS
   30       NUU = NU
   31       NDD = ND
   32       GO TO 35
      C     LIMITS FOR PUFF RELEASE WITH SPECIFIED WIND CONDITIONS
   33    30 NSS = 1
   34       NUU = 1
   35       NDD = 1
   36       FF = 1.
      C
      C     LOOP OVER RADIAL INCREMENTS
   37    35 DO 75 J = 1,NR
      C     ZERO DIRECTIONAL SUMS
   38       SUM = 0.
   39       SUMD = 0.
   40       SUMF = 0.
   41       SUMW = 0.
      C     MULTIPLIER FOR SECTOR AVERAGED CHI OVER Q
   42       IF(.NOT.MAXIND) XM = 2.0318/RM(J)
      C     LOOP OVER STABILITY CLASSES
   43       DO 55 MM = 1,NSS
   44       M = MM
   45       IF (KS.NE.0) M = KS
   46       SIGZ = SIGMAZ(RM(J),M)
      C     MULTIPLIER FOR PLUME CENTERLINE CHI OVER Q
   47       IF (MAXIND) XM = 1./(3.14159265*SIGMAY(RM(J),M))
      C     LOOP OVER WIND SPEEDS
   48       DO 50 L = 1,NUU
      C     CHI/Q WITHOUT DEPLETION FOR GIVEN J, M, L
   49       XOQ = XM*EXPF(-0.5*(H(L)/SIGZ)**2)/(U(L)*SIGZ)
      C     DRY DEPLETION FACTOR
   50       DDF = EXPF(-0.797885*VD1*DINT(RM(J),H(L),M)/U(L))
      C     WET DEPLETION FACTOR
```

```
      WDF = EXPF(-RC*RM(J)/U(L))
C     LOOP OVER WIND DIRECTIONS
      IF (KS.LE.0) FF = F(L,M)
      SUM = SUM + DDF*XOQ*FF
      SUM0 = SUM0 + XOQ*FF
      SUMW = SUMW + WDF*XOQ*FF
      SUMF = SUMF + FF/U(L)
   50 CONTINUE
   55 CONTINUE
C     CALCULATE AIR AND GROUND CONCENTRATIONS
      DO 70 I = 1,NI
      DUM = SUM0
      DUMW = DUM
      DUMF = 0.
      IF (VD(I).LE.0.) GO TO 60
      DUM = SUM
      DUMW = SUMW
      DUMF = SUMF
   60 AC(I,J) = CI(I)*(DUM*(1.-FR) + DUMW*FR)
      CC(I,J) = CI(I)*(DUM*(1.-FR)*VD(I) + 2.5465*DUMF*FR*RC/RM(J))
   70 CONTINUE
   75 CONTINUE
      RETURN
      END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 7C0 | CK1 | -R | 7C0 | CONCOF | ()R | 4C0 | E | ()R | 4C0 | IPASS | -I | 4C0 | RDCSP | -R | 7C0 | VAR2 | - | 6CN |
| ANG | -R | 7C0 | CK11 | -R | 7C0 | CONQ | -R | 4C0 | FDATA | - | 6CN | K | -I | 4C0 | REAL | - | 3F | W | ()R | 4C0 |
| ANGL | -R | 7C0 | CK13 | -R | 7C0 | CUHF | -R | 4C0 | FL | -R | 7C0 | LOCICA | - | 2F | RETURN | - | 71F | WATH | -R | 4C0 |
| ANGWND | -R | 7C0 | CK2 | -R | 7C0 | DATA | - | 11F | FW | -R | 7C0 | ORIENT | ()R | 4C0 | SAIR | -R | 7C0 | WATL | -R | 4C0 |
| ANS | -R | 7C0 | CK3 | -R | 7C0 | DD | ()R | 4C0 | HDRY | -R | 4C0 | P | ()R | 4C0 | SIGHAZ | - | 46SU | WC | ()R | 5C0 |
| AREA | ()R | 8C0 | CK4 | -R | 7C0 | DELW | -R | 4C0 | HTBR | -R | 7C0 | PAC84 | -R | 7C0 | SOLFAC | ()R | 4C0 | WNDFRC | -R | 7C0 |
| ATM01 | - | 8CN | CK5 | -R | 7C0 | DIMENS | - | 10F | HWET | -R | 4C0 | R | -R | 7C0 | TINDRY | -R | 4C0 | XD | ()R | 4C0 |
| ATM02 | - | 9CN | CK6 | -R | 7C0 | DINT | - | 50SU | HYDRA | - | 4CN | RAIN | -R | 4C0 | TIMINC | -R | 4C0 | | | |
| ATMOS | - | 1SU | CK8 | -R | 7C0 | DNSTY | ()R | 4C0 | ICALL | -I | 7C0 | RDCHT | -R | 7C0 | TINWET | -R | 4C0 | | | |
| CFCT | -R | 6C0 | CK9 | -R | 7C0 | DRY | -R | 4C0 | IN | -I | 4C0 | RDCRCH | -R | 7C0 | VAR | - | 7CN | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC | ()R | 9C0 | 67= | | | | | | | | | | |
| AY | ()R | 10D1 | 11DA | 12 | | | | | | | | | |
| CI | ()R | 5C0 | 67 | 68 | | | | | | | | | |
| COMMON | - | 4F | 5F | 6F | 7F | 8F | 9F | | | | | | |
| DDF | -R | 50= | 53 | | | | | | | | | | |
| DUM | -R | 13= | 14 | 14= | 14 | 17 | 60= | 61 | 64= | 67 | 68 | | |
| DUMF | -R | 62= | 66= | 68 | | | | | | | | | |
| DUMW | -R | 61= | 65= | 67 | | | | | | | | | |
| EXPF | - | 49SU | 50SU | 51SU | | | | | | | | | |
| F | ()R | 8C0 | 52 | | | | | | | | | | |
| FF | -R | 36= | 52= | 53 | 54 | 55 | 56 | | | | | | |
| FR | -R | 8C0 | 27 | 27 | 67 | 67 | 68 | 68 | | | | | |
| GC | ()R | 9C0 | 68= | | | | | | | | | | |
| H | ()R | 10D1 | 16= | 17= | 49 | 50 | | | | | | | |
| I | -I | 12 | 12 | 19D0 | 20 | 21 | 59D0 | 63 | 67 | 67 | 68 | 68 | 68 |
| IF | - | 14F | 17F | 20F | 27F | 28F | 42F | 45F | 47F | 52F | 63F | | |
| J | -I | 37D0 | 42 | 46 | 47 | 50 | 51 | 67 | 68 | 68 | | | |
| KLSP | -R | 3RL | 7C0 | | | | | | | | | | |
| KS | -I | 8C0 | 28 | 45 | 45 | 52 | | | | | | | |
| L | -I | 15D0 | 16 | 17 | 17 | 17 | 48D0 | 49 | 49 | 50 | 50 | 51 | 52 | 56 |
| M | -I | 44= | 45= | 46 | 47 | 50 | 52 | | | | | | |
| MAT | -R | 3RL | 7C0 | | | | | | | | | | |
| MAXIND | -L | 2LC | 5C0 | 42 | 47 | | | | | | | | |
| MM | -I | 43D0 | 44 | | | | | | | | | | |
| ND | -I | 4C0 | 11DA | 31 | | | | | | | | | |
| NDD | -I | 31= | 35= | | | | | | | | | | |
| NI | -I | 4C0 | 19D0 | 59D0 | | | | | | | | | |
| NR | -I | 8C0 | 37D0 | | | | | | | | | | |
| NS | -I | 8C0 | 29 | | | | | | | | | | |
| NSS | -I | 8C0 | 29= | 33= | 43D0 | | | | | | | | |
| NU | -I | 7C0 | 15D0 | 30 | | | | | | | | | |
| NUU | -I | 30= | 34= | 48D0 | | | | | | | | | |
| RC | -R | 26= | 27= | 51 | 68 | | | | | | | | |
| RF | -R | 8C0 | 27 | 27 | | | | | | | | | |
| RH | ()R | 8C0 | 42 | 46 | 47 | 50 | 51 | 68 | | | | | |
| SH | -R | 8C0 | 13 | 13 | 16 | 17 | | | | | | | |
| SIGHAY | - | 12SU | 47SU | | | | | | | | | | |
| SIGZ | -R | 46= | 49 | 49 | | | | | | | | | |
| SQ | -R | 8C0 | 13 | | | | | | | | | | |
| SUM | -R | 38= | 53= | 53 | 64 | | | | | | | | |
| SUM0 | -R | 39= | 54= | 54 | 60 | | | | | | | | |
| SUMF | -R | 40= | 56= | 56 | 66 | | | | | | | | |
| SUMW | -R | 41= | 55= | 55 | 65 | | | | | | | | |
| U | ()R | 6C0 | 17 | 17 | 49 | 50 | 51 | 56 | | | | | |
| VD | ()R | 5C0 | 20 | 21 | 63 | 68 | | | | | | | |

```
     INDEX    4/12/80
VDI          -R   21=     24=     50
WDF          -R   51=     55
X            -R   12      12
XM           -R   42=     47=     49
XOQ          -R   49=     53      54      53
     5       -    15DO    18*
     15      -    19DO    20      23*
     20      -    22      25*
     25      -    20      28      29*
     30      -    28      33*
     35      -    32      37*
     50      -    48DO    57*
     55      -    43DO    56*
     60      -    63      67*
     70      -    59DO    69*
     75      -    37DO    70*
```

```
      FUNCTION SIGMAZ(X,I)
C
C*ABSTRACT: Calculates the plume vertical standard deviation for
C           gaussian plume model.
C
C*AUTHOR: J STODDARD
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       X - Distance from source (meters)
CIN       I - Pasquill stability category (1=a,7=g)
C
C*CALLED BY:
C          ATMOS
C
C*CALLS TO:
C          NONE
C
C*TECHNICAL DESCRIPTION:
C            This routine calculates the plume vertical standard
C            deviation for gaussian plume model using NRC program
C            XOQDOQ formula and data.
C
      DIMENSION A(6,3),B(6,3),C(6,3),D(2)
      DATA A/.192,.156,.116,.079,.063,.053,.00066,.0382,.113,.222,
     *   .211,.086,.00024,.055,.113,1.26,6.73,18.05/
      DATA B/.936,.922,.905,.881,.871,.814,1.941,1.149,.911,
     *   .725,.678,.74,2.094,1.098,.911,.516,.305,.18/
      DATA C/6*0.,9.27,3.3,0.,-1.7,-1.3,-.35,-9.6,2.,0.,-13.,-34.,-48.6/
      DATA D/100.,1000./
      DO 5 L = 1,2
      IF (X.LT.D(L)) GO TO 10
    5 CONTINUE
      L = 3
   10 IF (I.EQ.7) GO TO 15
      SIGMAZ = A(I,L)*X**B(I,L) + C(I,L)
      GO TO 20
   15 F1 = A(6,L)*X**B(6,L) + C(6,L)
      F2 = A(5,L)*X**B(5,L) + C(5,L)
      SIGMAZ = F1*F1/F2
   20 IF (SIGMAZ.GT.1000.) SIGMAZ = 1000.
      IF (SIGMAZ.LT.1.) SIGMAZ = 1.
      RETURN
      END
```

SINGLY REFERENCED VARIABLES
DIMENS - 2F RETURN - 19F

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | ()R | 2D1 | 3DA | 12 | 14 | 15 | | | | | | | |
| B | ()R | 2D1 | 4DA | 12 | 14 | 15 | | | | | | | |
| C | ()R | 2D1 | 5DA | 12 | 14 | 15 | | | | | | | |
| D | ()R | 2D1 | 6DA | 8 | | | | | | | | | |
| DATA | - | 3F | 4F | 5F | 6F | | | | | | | | |
| F1 | -R | 14= | 16 | 16 | | | | | | | | | |
| F2 | -R | 15= | 16 | | | | | | | | | | |
| I | -I | 1AC | 11 | 12 | 12 | 12 | | | | | | | |
| IF | - | 8F | 11F | 17F | 18F | | | | | | | | |
| L | -I | 7D0 | 8 | 10= | 12 | 12 | 12 | 14 | 14 | 14 | 15 | 15 | 15 |
| SIGMAZ | - | 1SU | 12= | 16= | 17 | 17= | 18 | 18= | | | | | |
| X | -R | 1AC | 8 | 12 | 14 | 15 | | | | | | | |
| 5 | - | 7D0 | 9* | | | | | | | | | | |
| 10 | - | 8 | 11* | | | | | | | | | | |
| 15 | - | 11 | 14* | | | | | | | | | | |
| 20 | - | 13 | 17* | | | | | | | | | | |

```
      1       FUNCTION DINT(X,H,M)
              C
              C*ABSTRACT: Provides the dry depletion integral.
              C
              C*AUTHOR: J STODDARD
              C
              C*TYPE: NUMERICAL ANALYSIS
              C
              C*PARAMETER DESCRIPTION:
              CIN       X - Downrange distance (meters)
              CIN       H - Effective release height (meters)
              CIN       M - Pasquill stability category, 1=a,7=g
              C
              C*CALLED BY:
              C           ATMOS
              C
              C*CALLS TO:
              C           EXPF
              C
              C*TECHNICAL DESCRIPTION:
              C             Provides the dry depletion integral by double
              C             interpolation of stored logarithmic data.
              C
      2             DIMENSION XB(9),HB(6),V(9,6,7),V1(162),V2(162),V3(54)
      3             EQUIVALENCE (V(1,1,1),V1(1)),(V(1,1,4),V2(1)),(V(1,1,7),V3(1))
              C     LOGARITHMS OF X AND H BREAKPOINTS
      4             DATA XB/2.3025,4.605,6.908,8.006,9.210,10.309,11.513,12.612,
                   + 13.816/
      5             DATA HB/-10.,3.,3.912,4.605,5.703,6.908/
              C     LOGARITHMS OF DEPLETION INTEGRAL DATA
      6             DATA V1/
                   +     2.20,  3.18,  3.59,  3.65,  3.82,  4.18,  4.91,  5.82,  6.94,
                   +   -50.00, -0.18,  2.35,  2.55,  2.98,  3.68,  4.70,  5.74,  6.92,
                   +   -50.00, -6.75,  1.69,  2.03,  2.68,  3.54,  4.65,  5.72,  6.91,
                   +   -50.00,-26.37,  1.12,  1.66,  2.50,  3.47,  4.62,  5.71,  6.91,
                   +   -50.00,-50.00, -0.17,  1.07,  2.26,  3.36,  4.56,  5.66,  6.86,
                   +   -50.00,-50.00, -4.14,  0.15,  1.69,  2.86,  4.09,  5.20,  6.41,
                   +     2.27,  3.37,  3.94,  4.11,  4.26,  4.51,  5.08,  5.89,  6.97,
                   +   -50.00, -0.98,  2.81,  3.26,  3.58,  4.02,  4.83,  5.79,  6.93,
                   +   -50.00,-11.37,  2.07,  2.84,  3.29,  3.85,  4.76,  5.76,  6.92,
                   +   -50.00,-44.31,  1.07,  2.40,  3.03,  3.70,  4.70,  5.73,  6.91,
                   +   -50.00,-50.00, -3.80,  1.16,  2.47,  3.43,  4.58,  5.67,  6.87,
                   +   -50.00,-50.00,-43.49, -3.98,  1.24,  2.75,  4.06,  5.19,  6.40,
                   +     2.30,  3.63,  4.27,  4.51,  4.73,  4.93,  5.34,  6.01,  7.01,
                   +   -50.00, -3.66,  3.00,  3.65,  4.12,  4.45,  5.05,  5.87,  6.96,
                   +   -50.00,-23.43,  1.97,  3.16,  3.83,  4.26,  4.94,  5.83,  6.95,
                   +   -50.00,-50.00,  0.12,  2.51,  3.52,  4.06,  4.85,  5.79,  6.93,
                   +   -50.00,-50.00,-12.42, -0.21,  2.62,  3.59,  4.64,  5.68,  6.87,
                   +   -50.00,-50.00,-50.00,-18.75, -0.66,  2.45,  3.99,  5.17,  6.40/
      7             DATA V2/
                   +     2.30,  3.95,  4.71,  5.03,  5.41,  5.80,  6.27,  6.73,  7.34,
                   +   -50.00, -9.43,  3.07,  4.08,  4.86,  5.46,  6.07,  6.61,  7.28,
                   +   -50.00,-50.00,  1.03,  3.26,  4.47,  5.25,  5.95,  6.54,  7.25,
                   +   -50.00,-50.00, -3.80,  1.67,  3.83,  4.92,  5.79,  6.45,  7.20,
                   +   -50.00,-50.00,-46.11, -9.36,  0.34,  3.43,  5.11,  6.09,  7.02,
                   +   -50.00,-50.00,-50.00,-50.00,-27.46, -5.92,  1.76,  4.59,  6.26,
                   +     2.30,  4.12,  4.96,  5.32,  5.77,  6.25,  6.86,  7.49,  8.23,
                   +   -50.00,-16.59,  2.90,  4.22,  5.17,  5.91,  6.69,  7.40,  8.19,
```

```
     +   -50.00,-50.00, -0.53,  2.95,  4.60,  5.61,  6.54,  7.32,  8.15,
     +   -50.00,-50.00, -9.80,  0.11,  3.44,  5.01,  6.23,  7.15,  8.06,
     +   -50.00,-50.00,-50.00,-23.02, -4.67,  1.21,  4.37,  6.12,  7.51,
     +   -50.00,-50.00,-50.00,-50.00,-50.00,-31.32, -9.80, -1.07,  3.86,
     +    2.30,  4.35,  5.33,  5.71,  6.19,  6.73,  7.43,  8.15,  9.01,
     +   -50.00,-39.89,  2.21,  4.21,  5.43,  6.32,  7.23,  8.05,  8.96,
     +   -50.00,-50.00, -4.60,  1.96,  4.41,  5.76,  6.93,  7.88,  8.86,
     +   -50.00,-50.00,-25.22, -3.93,  1.94,  4.42,  6.19,  7.43,  8.59,
     +   -50.00,-50.00,-50.00,-50.00,-18.61, -5.99,  0.58,  4.02,  6.54,
     +   -50.00,-50.00,-50.00,-50.00,-50.00,-50.00,-50.00,-26.49,-11.10/
   8       DATA V3/
     +     2.30,  4.53,  5.69,  6.09,  6.61,  7.22,  8.01,  8.83,  9.80,
     +   -50.00,-50.00,  0.56,  3.93,  5.55,  6.64,  7.71,  8.66,  9.70,
     +   -50.00,-50.00,-13.95, -0.51,  3.45,  5.39,  6.95,  8.15,  9.35,
     +   -50.00,-50.00,-50.00,-13.68, -2.45,  1.89,  4.74,  6.60,  8.26,
     +   -50.00,-50.00,-50.00,-50.00,-50.00,-29.76,-14.96, -7.21, -1.65,
     +   -50.00,-50.00,-50.00,-50.00,-50.00,-50.00,-50.00,-50.00,-50.00/
C
   9       DINT = 2.E-22
  10       IF (X.LT.10.) RETURN
  11       XL = ALOG(X)
  12       DO 10 II = 2,9
  13       I = II
  14       IF (XL.LE.XB(I)) GO TO 20
  15    10 CONTINUE
  16    20 FX = (XL - XB(I-1))/(XB(I) - XB(I-1))
  17       IF (H.GT.10.) GO TO 30
C      SINGLE INTERPOLATION FOR GROUND LEVEL RELEASE
  18       DINT = V(I-1,1,M) + (V(I,1,M) - V(I-1,1,M))*FX
  19       DINT = EXPF(DINT)
  20       RETURN
C      DOUBLE INTERPOLATION FOR ABOVE-GROUND RELEASE
  21    30 HL = ALOG(H)
  22       DO 40 JJ = 2,6
  23       J = JJ
  24       IF (HL.LE.HB(J)) GO TO 50
  25    40 CONTINUE
  26    50 FH = (HL-HB(J-1))/(HB(J)-HB(J-1))
  27       DINT = V(I-1,J-1,M)+(V(I,J-1,M)-V(I-1,J-1,M))*FX +
     +     (V(I-1,J,M)-V(I-1,J-1,M))*FH + (V(I,J,M)+V(I-1,J-1,M)
     +     -V(I-1,J,M) -V(I,J-1,M))*FX*FH
  28       DINT = EXPF(DINT)
  29       RETURN
  30       END
```

SINGLY REFERENCED VARIABLES

DIMENS - 2F EQUIVA - 3F

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALOG | - | 11SU | 21SU | | | | | | | | | | | | | | | |
| DATA | - | 4F | 5F | 6F | 7F | 8F | | | | | | | | | | | | |
| DINT | - | 1SU | 9= | 18= | 19= | 19 | 27= | 28= | 28 | | | | | | | | | |
| EXPF | - | 19SU | 20SU | | | | | | | | | | | | | | | |
| FH | -R | 26= | 27 | 27 | | | | | | | | | | | | | | |
| FX | -R | 16= | 18 | 27 | 27 | | | | | | | | | | | | | |
| H | -R | 1AC | 17 | 21 | | | | | | | | | | | | | | |
| HB | ()R | 2D1 | 5DA | 24 | 26 | 26 | 26 | | | | | | | | | | | |
| HL | -R | 21= | 24 | 26 | | | | | | | | | | | | | | |
| I | -I | 13= | 14 | 16 | 16 | 16 | 18 | 18 | 18 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| IF | - | 10F | 14F | 17F | 24F | | | | | | | | | | | | | |
| II | -I | 12DO | 13 | | | | | | | | | | | | | | | |
| J | -I | 23= | 24 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | | | |
| JJ | -I | 22DO | 23 | | | | | | | | | | | | | | | |
| M | -I | 1AC | 18 | 18 | 18 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | | | | |
| RETURN | - | 10F | 20F | 29F | | | | | | | | | | | | | | |
| V | ()R | 2D1 | 3EQ | 3EQ | 3EQ | 18 | 18 | 18 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | |
| V1 | ()R | 2D1 | 3EQ | 6DA | | | | | | | | | | | | | | |
| V2 | ()R | 2D1 | 3EQ | 7DA | | | | | | | | | | | | | | |
| V3 | ()R | 2D1 | 3EQ | 8DA | | | | | | | | | | | | | | |
| X | -R | 1AC | 10 | 11 | | | | | | | | | | | | | | |
| XB | ()R | 2D1 | 4DA | 14 | 16 | 16 | 16 | | | | | | | | | | | |
| XL | -R | 11= | 14 | 16 | | | | | | | | | | | | | | |
| 10 | - | 12DO | 15* | | | | | | | | | | | | | | | |
| 20 | - | 14 | 16* | | | | | | | | | | | | | | | |
| 30 | - | 17 | 21* | | | | | | | | | | | | | | | |
| 40 | - | 22DO | 25* | | | | | | | | | | | | | | | |
| 50 | - | 24 | 26* | | | | | | | | | | | | | | | |

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      SUBROUTINE DOSET(T)
C
C*ABSTRACT: Calculates the population dose for different paths.
C
C*AUTHOR: J STODDARD
C
C*TYPE: NUMERICAL ANALYSIS
C
C*PARAMETER DESCRIPTION:
CIN       T - Time duration for release (years)
C
C*CALLED BY:
C         EXEC
C
C*CALLS TO:
C         EXPF, SUMDOS
C
C*COMMON BLOCKS:
CNAME      HDATA
C           dc
CNAME      NDATA
C           dosfac, tid
CNAME      EDATA
C           biv, fm, ff
CNAME      HYDRA
C           nl
CNAME      ATM02
C           gc, ac
CNAME      ATM01
C           nj, area
CNAME      FDATA
C           wc, maxind
CNAME      DOSEB
C           beef, cows, fage, fva, ncpy, produc, ip, flowr
C
C*TECHNICAL DESCRIPTION:
C            Calculates the population dose for cloud shine, ground
C            shine, inhalation, and ingestion pathways.
C
      LOGICAL MAXIND
      DIMENSION BR(3),WU(3),FVG(3),VL(3),XMILK(3),XMEAT(3)
     +  ,UGRAIN(3),UMILK(3),UMEAT(3),UVEG(3),UG(3),UMK(3),UMT(3),UV(3)
      COMMON/HDATA/ DC(45)
      COMMON/NDATA/ DOSFAC(45,8,9),CE(45,10),TID(45)
      COMMON/EDATA/BIV(45),FM(45),FF(45)
      COMMON/HYDRA/JK,ND,IN,NI,DELW,RAIN,DRY,TIMWET,TIMDRY,DD(60),
     1 P(52),E(52),WA(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,CONCOF(60),
     2 DNSTY(60),XD(45,60),SOLFAC(45),ORIENT(45),CUMT,IPASS
      COMMON/ATM02/GC(45,20),AC(45,20)
      COMMON/ATM01/NS,KS,NSS,F(10,7),FR,RF,NJ,RH(20),SH,SQ,AREA(20)
      COMMON/FDATA/C1(45),VD(45),WC(45),MAXIND
      COMMON/DOSEB/ BEEF,COWS,FACE(3),FVA,NCPY,PRODUC,IP(20),FLOWR
C     BREATHING RATE  CHILD, TEEN, ADULT, M**3/YEAR PER REG GUIDE 1.109
      DATA BR/3700.,8000.,8000./
C     DRINKING WATER USAGE PER PERSON, LITERS/YEAR
      DATA WU/510.,510.,730./
C     FRUIT, VEG, GRAIN PER PERSON, KG/YR
      DATA FVG/520.,630.,520./
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      C     LEAFY VEGETABLES PER PERSON, KG/YR
      15    DATA VL/26.,42.,64./
      C     MILK PER PERSON, LITERS/YR
      16    DATA XMILK/330.,400.,310./
      C     MEAT PER PERSON, KG/YR
      17    DATA XMEAT/41.,65.,110./
      C     LEAFY VEGETABLE CROP DENSITY, KG/M**2
      18    DATA CDLV/1./
      C     SOIL POOL, KG/METER**2
      19    DATA POOL/240./
      C     COW GRASS CONSUMPTION, KG/DAY, AREAL GRASS DENSITY, KG/M**2
      20    DATA QF/50./,AGD/0.7/
      C     BEEF DRESSOUT FRACTION, SLAUGHTER FRACTION PER YEAR
      C     COW WEIGHT, KG, MILK PRODUCTION, LITERS PER YEAR PER COW
      21    DATA FD/0.5/,FS/0.33333/,W/500./,QM/4380./
      C     NUMBER OF AGE GROUPS NM, NUMBER OF ORGANS NL
      22    DATA NM/3/,NL/9/
      C     RELATIVE FOOD AND DRINK CONSUMPTION RATES BY AGE GROUP
      23    DATA UGRAIN/200.,240.,190./,UMILK/170.,200.,110./
      24    DATA UMEAT/37.,59.,95./,UVEG/26.,42.,64./
      C
      C     ESTIMATED FOOD AND DRINK CONSUMPTION FRACTION BY AGE GROUP
      25          DO 2 M = 1,NM
      26          UG(M) = UGRAIN(M)*FAGE(M)/(UGRAIN(1)*FAGE(1)+UGRAIN(2)*
                 +    FAGE(2) + UGRAIN(3)*FAGE(3))
      27          UMK(M) = UMILK(M)*FAGE(M)/(UMILK(1)*FAGE(1)+UMILK(2)*FAGE(2)+
                 +    UMILK(3)*FAGE(3))
      28          UMT(M) = UMEAT(M)*FAGE(M)/(UMEAT(1)*FAGE(1)+UMEAT(2)*FAGE(2)+
                 +    UMEAT(3)*FAGE(3))
      29          UV(M) = UVEG(M)*FAGE(M)/(UVEG(1)*FAGE(1)+UVEG(2)*FAGE(2)+
                 +    UVEG(3)*FAGE(3))
      30        2 CONTINUE
      C
      C     LOOP OVER NI ISOTOPES
      C
      31          DO 50 I = 1,NI
      32          II = I
      C     CROP DEPOSITION FACTOR, 0.25 FOR ALL EXCEPT IODINE PER R.G.1.109
      33          RI = 0.25
      34          IF (IID(I)/10000.EQ.53) RI = 1.
      C
      C     DECAY CONST FOR NUCLIDE
      35          DCI = DC(I)
      C     EFFECTIVE DECAY CONST FOR GROUND SURFACE CONTAMINATION
      36          DCE = DC(I) + 0.677
      C     EXPONENTIAL FACTORS FOR LEAFY VEGETABLES AND GRASS
      37          DCG = DC(I) + 18.4
      38          TDCN=1.
      39          IF (DCG/FLOAT(NCPY).GT.2.E-4) TDCN=(1.-EXPF(-DCG/FLOAT(NCPY)))/
                 +    DCG
      C     EFFECTIVE DECAY CONST FOR SOIL POOL
      40          DCS = DC(I) + 0.2
      C
      C     PATHWAY 1 - EXTERNAL DOSE FROM CLOUD SHINE
      C
      41          KK = 1
      42          DO 5 J = 1,NJ
      43          JJ = J
```

```
      DO 5 L = 1,NL
      LL = L
      DO 5 M = 1,NM
      MM = M
      DOSE = AC(I,J)*DOSFAC(I,1,L)/3600.
      IF (.NOT.MAXIND) DOSE=DOSE*IP(J)*FACE(M)
      IF ((IP(J).EQ.0.OR.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
    5 CONTINUE
C
C     PATHWAY 2 - EXTERNAL DOSE FROM GROUND SHINE
C
      KK = 2
      DO 10 J = 1,NJ
      JJ = J
      DO 10 L = 1,NL
      LL = L
      DO 10 M = 1,NM
      MM = M
      DOSE = 8760.*CC(I,J)*DOSFAC(I,2,L)/DCE
      IF (.NOT.MAXIND) DOSE = DOSE*IP(J)*FACE(M)
      IF ((IP(J).EQ.0.OR.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   10 CONTINUE
C
C     PATHWAY 3 - INHALATION DOSE
C
C     DOSE DUE TO INHALATION OF PLUME
      KK = 3
      DO 15 J = 1,NJ
      JJ = J
      DO 15 L = 1,NL
      LL = L
      DO 15 M = 1,NM
      MM = M
      DOSE = BR(M)*AC(I,J)*DOSFAC(I,M+2,L)/31536000.
      IF (.NOT.MAXIND) DOSE = DOSE*IP(J)*FACE(M)
      IF ((IP(J).EQ.0.OR.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   15 CONTINUE
C     DOSE DUE TO INHALATION OF RESUSPENDED PARTICLES
      KK = 4
      DUM = 1.E-5/DCE + 1.E-9/DC(I)
      DO 20 J = 1,NJ
      JJ = J
      DO 20 L = 1,NL
      LL = L
      DO 20 M = 1,NM
      MM = M
      DOSE = BR(M)*CC(I,J)*DOSFAC(I,M+2,L)*DUM
      IF (.NOT.MAXIND) DOSE = DOSE*IP(J)*FACE(M)
      IF ((IP(J).EQ.0.OR.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   20 CONTINUE
C
C     PATHWAY 4 - INGESTION DOSE
C
C     INGESTION OF CONTAMINATED WATER
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```
      KK = 5
      IF(FLOWR.EQ.0.0) GO TO 26
      DO 25 J = 1,NJ
      JJ = J
      DO 25 L = 1,NL
      LL = L
      DO 25 M = 1,NM
      MM = M
      DOSE = WC(I)*WU(M)*DOSFAC(I,M+5,L)/FLOWR
      IF (.NOT.MAXIND) DOSE = DOSE*IP(J)*FACE(M)
      IF (IP(J).EQ.0.OR.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   25 CONTINUE
   26 CONTINUE
C     INGESTION OF LEAFY VEGETABLES
      KK = 6
      DUM = FLOAT(NCPY)*RI*FVA*1.E6*TDCN*EXPF(-2.74E-3*DCI)
      DO 30 J = 1,NJ
      JJ = J
      DO 30 L = 1,NL
      LL = L
      DO 30 M = 1,NM
      MM = M
      IF(.NOT.MAXIND) DOSE = CC(I,J)*AREA(J)*DOSFAC(I,M+5,L)*DUM*UV(M)
      IF (MAXIND) DOSE = CC(I,J)*DOSFAC(I,M+5,L)*RI*TDCN
     +   *EXPF(-2.74E-3*DCI)/CDLV
      IF (MAXIND.AND.IP(J).EQ.0) DOSE = 0.
      IF (MAXIND.AND.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   30 CONTINUE
      IF (PRODUC.LE.0.) GO TO 36
C     INGESTION OF FRUITS, NUTS, GRAIN, ROOT CROPS
      KK = 7
      DUM = PRODUC*BIV(I)*EXPF(-0.030*DCS)/(POOL*DCS)
      DO 35 J = 1,NJ
      JJ = J
      DO 35 L = 1,NL
      LL = L
      DO 35 M = 1,NM
      MM = M
      IF (.NOT.MAXIND) DOSE = AREA(J)*CC(I,J)*DOSFAC(I,M+5,L)*UC(M)*DUM
      IF (MAXIND) DOSE = CC(I,J)*DOSFAC(I,M+5,L)*DUM*FVC(M)/PRODUC
      IF (MAXIND.AND.IP(J).EQ.0) DOSE = 0.
      IF (MAXIND.AND.FACE(M).EQ.0.) DOSE = 0.
      CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
   35 CONTINUE
   36 CONTINUE
C
C     INGESTION OF MILK
      IF (COWS.LE.0.) GO TO 41
      KK = 8
      DUM = QF*QM*RI*COWS*EXPF(-0.011*DC(I))/(ACD*DCC)
      DO 40 J = 1,NJ
      JJ = J
      DO 40 L = 1,NL
      LL = L
      DO 40 M = 1,NM
      MM = M
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INDEX   4/12/00                    SUBROUTINE DOSET(T)
      143                 IF (.NOT.MAXIND) DOSE = CC(I,J)*FM(I)*AREA(J)*DOSFAC(I,M+5,L)
     +                      *UPK(M)*DUM
      144                 IF (MAXIND) DOSE = CC(I,J)*FM(I)*DOSFAC(I,M+5,L)*DUM/(COWS*QM)
      145                 IF (MAXIND.AND.IP(J).EQ.0) DOSE = 0.
      146                 IF (MAXIND.AND.FACE(M).EQ.0.) DOSE = 0.
      147                 CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
      148              40 CONTINUE
      149              41 CONTINUE
                     C     INGESTION OF BEEF
      150                 IF (BEEF.LE.0.) GO TO 50
      151                 KK = 9
      152                 DUM = FD*FS*W*QF*BEEF*RI*EXPF(-0.055*DC(I))/(ACD*DCG)
      153                 DO 45 J = 1,NJ
      154                 JJ = J
      155                 DO 45 L = 1,NL
      156                 LL = L
      157                 DO 45 M = 1,NM
      158                 MM = M
      159                 IF (.NOT.MAXIND) DOSE = DUM*AREA(J)
     +                      *FF(I)*CC(I,J)*DOSFAC(I,M+5,L)*UMT(M)
      160                 IF (MAXIND) DOSE = CC(I,J)*DUM*FF(I)*DOSFAC(I,M+5,L)
     +                      *XHEAT(M)/(BEEF*FD*W*FS)
      161                 IF (MAXIND.AND.IP(J).EQ.0) DOSE = 0.
      162                 IF (MAXIND.AND.FACE(M).EQ.0.) DOSE = 0.
      163                 CALL SUMDOS(II,JJ,KK,LL,MM,DOSE)
      164              45 CONTINUE
      165              50 CONTINUE
      166                 DO 55 I=1,NI
      167                 DO 54 J=1,NJ
      168                 AC(I,J)=0.
      169                 CC(I,J)=0.
      170              54 CONTINUE
      171                 WC(I)=0.
      172              55 CONTINUE
      173                 RETURN
      174                 END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATM01 | - | 9CN | DIMENS | - | 3F | FDATA1 | - | 10CN | IPASS | -I | 7C0 | ORIENT | ()R | 7C0 | SQ | -R | 9C0 | WATL | -R | 7C0 |
| ATM02 | - | 8CN | DRSTY | ()R | 7C0 | FR | -R | 9C0 | JK | -I | 7C0 | P | ()R | 7C0 | T | -R | 1AC | XD | ()R | 7C0 |
| CI | ()R | 10C0 | DOSEB | - | 11CN | GE | ()R | 6C0 | KS | -I | 9C0 | RAIN | -R | 7C0 | TIMDRY | -R | 7C0 | | | |
| CONCOF | ()R | 7C0 | DOSET | - | 1SU | HDATA | - | 4CN | LOGICA | - | 2F | RETURN | - | 173F | TIMINC | -R | 7C0 | | | |
| CONQ | -R | 7C0 | DRY | -R | 7C0 | HDRY | -R | 7C0 | ND | -I | 7C0 | RF | -R | 9C0 | TIMWET | -R | 7C0 | | | |
| CUNT | -R | 7C0 | E | ()R | 7C0 | HWET | -R | 7C0 | NDATA | - | 5CN | RH | ()R | 9C0 | VD | ()R | 10C0 | | | |
| DD | ()R | 7C0 | EDATA | - | 6CN | HYDRA1 | - | 7CN | NS | -I | 9C0 | SH | -R | 9C0 | VA | ()R | 7C0 | | | |
| DELW | -R | 7C0 | F | ()R | 9C0 | I | -I | 7C0 | NSS | -I | 9C0 | SOLFAC | ()R | 7C0 | WATH | -R | 7C0 | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC | ()R | 8C0 | 48 | 72 | 168* | | | | | | | | | | | | | | |
| ACD | -R | 20DA | 136 | 152 | | | | | | | | | | | | | | | |
| AREA | ()R | 9C0 | 112 | 127 | 143 | 159 | | | | | | | | | | | | | |
| BEEF | -R | 11C0 | 150 | 152 | 160 | | | | | | | | | | | | | | |
| BIV | ()R | 6C0 | 120 | | | | | | | | | | | | | | | | |
| BR | ()R | 9D1 | 12DA | 72 | 85 | | | | | | | | | | | | | | |
| CALL | - | 51F | 63F | 75F | 88F | 101F | 116F | 131F | 147F | 163F | | | | | | | | | |
| COLV | -R | 10DA | 113 | | | | | | | | | | | | | | | | |
| COMMON | - | 4F | 5F | 6F | 7F | 8F | 9F | 10F | 11F | | | | | | | | | | |
| COMS | -R | 11C0 | 134 | 136 | 144 | | | | | | | | | | | | | | |
| DATA | - | 12F | 13F | 14F | 15F | 16F | 17F | 18F | 19F | 20F | 21F | 22F | 23F | 24F | | | | | |
| DC | ()R | 4C0 | 35 | 36 | 37 | 40 | 70 | 136 | 152 | | | | | | | | | | |
| DCE | -R | 36* | 60 | 70 | | | | | | | | | | | | | | | |
| DCC | -R | 37* | 39 | 39 | 39 | 136 | 152 | | | | | | | | | | | | |
| DCI | -R | 35* | 105 | 113 | | | | | | | | | | | | | | | |
| DCS | -R | 40* | 120 | 120 | | | | | | | | | | | | | | | |
| DOSE | -R | 48* | 49* | 49 | 50* | 51AC | 60* | 61* | 61 | 62* | 63AC | 72* | 73* | 73 | 74* | 75AC | 85* | 86* | |
| | | 86 | 87* | 88AC | 98* | 99* | 99 | 100* | 101AC | 112* | 113* | 114* | 115* | 116AC | 127* | 128* | 129* | 130* | |
| | | 131AC | 143* | 144* | 145* | 146* | 147AC | 159* | 160* | 161* | 162* | 163AC | | | | | | | |
| DOSFAC | ()R | 5C0 | 48 | 60 | 72 | 85 | 98 | 112 | 113 | 127 | 128 | 143 | 144 | 159 | 160 | | | | |
| DUM | -R | 78* | 85 | 105* | 112 | 120* | 127 | 128 | 136* | 143 | 144 | 152* | 159 | 160 | | | | | |
| EXPF | - | 39SU | 105SU | 113SU | 120SU | 136SU | 152SU | | | | | | | | | | | | |
| FACE | ()R | 11C0 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | |
| | | 49 | 50 | 61 | 62 | 73 | 74 | 86 | 87 | 99 | 100 | 115 | 130 | 146 | 162 | | | | |
| FD | -R | 21DA | 152 | 160 | | | | | | | | | | | | | | | |
| FF | ()R | 6C0 | 159 | 160 | | | | | | | | | | | | | | | |
| FLOAT | - | 39SU | 39SU | 105SU | | | | | | | | | | | | | | | |
| FLOWR | -R | 11C0 | 91 | 98 | | | | | | | | | | | | | | | |
| FM | ()R | 6C0 | 143 | 144 | | | | | | | | | | | | | | | |
| FS | -R | 21DA | 152 | 160 | | | | | | | | | | | | | | | |
| FVA | -R | 11C0 | 105 | | | | | | | | | | | | | | | | |
| FVC | ()R | 3D1 | 14DA | 128 | | | | | | | | | | | | | | | |
| GC | ()R | 8C0 | 60 | 85 | 112 | 113 | 127 | 128 | 143 | 144 | 159 | 160 | 169* | | | | | | |
| I | -I | 3100 | 32 | 34 | 35 | 36 | 37 | 40 | 48 | 48 | 60 | 60 | 72 | 72 | 78 | 85 | 85 | 98 | |
| | | 98 | 112 | 112 | 113 | 113 | 120 | 127 | 127 | 128 | 128 | 136 | 143 | 143 | 143 | 144 | 144 | 144 | |
| | | 152 | 159 | 159 | 159 | 160 | 160 | 160 | 166DO | 160 | 169 | 171 | | | | | | | |
| IF | - | 34F | 39F | 49F | 50F | 61F | 62F | 73F | 74F | 86F | 87F | 91F | 99F | 100F | 112F | 113F | 114F | 115F | |
| | | 118F | 127F | 128F | 129F | 130F | 134F | 143F | 144F | 145F | 146F | 150F | 159F | 160F | 161F | 162F | | | |
| II | -I | 32* | 51AC | 63AC | 75AC | 88AC | 101AC | 116AC | 131AC | 147AC | 163AC | | | | | | | | |
| IID | ()I | 5C0 | 34 | | | | | | | | | | | | | | | | |
| IF | ()I | 11C0 | 49 | 50 | 61 | 62 | 73 | 74 | 86 | 87 | 99 | 100 | 114 | 129 | 145 | 161 | | | |
| J | -I | 42D0 | 43 | 48 | 49 | 50 | 54D0 | 55 | 60 | 61 | 62 | 66D0 | 67 | 72 | 73 | 74 | 79D0 | 80 | |
| | | 85 | 86 | 87 | 92D0 | 93 | 99 | 100 | 106D0 | 107 | 112 | 112 | 113 | 114 | 121D0 | 122 | 127 | 127 | |
| | | 128 | 129 | 137D0 | 138 | 143 | 143 | 144 | 145 | 153D0 | 154 | 159 | 159 | 160 | 161 | 167D0 | 168 | 169 | |
| JJ | -I | 43* | 51AC | 55* | 63AC | 67* | 75AC | 80* | 88AC | 93* | 101AC | 107* | 116AC | 122* | 131AC | 136* | 147AC | 154* | |
| | | 163AC | | | | | | | | | | | | | | | | | |

KK -I 41= 51AC 53= 63AC 65= 75AC 77= 88AC 90= 101AC 104= 116AC 119= 131AC 135= 147AC 151= 163AC

L -I 44D0 45 48 56D0 57 60 68D0 69 72 81D0 82 85 94D0 95 98 106D0 109 112 113 123D0 124 127 128 139D0 140 143 144 155D0 156 159 160

LL -I 45= 51AC 57= 63AC 69= 75AC 82= 88AC 95= 101AC 109= 116AC 124= 131AC 140= 147AC 156= 163AC

M -I 25D0 26 26 26 27 27 27 28 28 28 29 29 29 46D0 47 49 50 25D0 59 61 62 70D0 71 72 72 73 74 83D0 84 85 83 86 87 96D0 97 98 98 99 100 110D0 111 112 112 113 115 125D0 126 127 127 128 129 130 141D0 142 143 143 144 146 157D0 158 159 159 160 160 162

MAXIND -I. 21C 10C0 49 61 73 86 99 112 113 114 115 127 128 129 130 143 144 145 146 159 160 161 162

MM -I 47= 51AC 59= 63AC 71= 75AC 84= 88AC 97= 101AC 111= 116AC 126= 131AC 142= 147AC 158= 163AC

NCFY -I 11C0 39 39 105

NI -I 7C0 31D0 166D0

NJ -I 9C0 42D0 54D0 66D0 79D0 92D0 106D0 121D0 137D0 153D0 167D0

NL -I 22DA 44D0 56D0 68D0 81D0 94D0 108D0 123D0 139D0 155D0

NM -I 22DA 25D0 46D0 58D0 70D0 83D0 96D0 110D0 125D0 141D0 157D0

POOL -R 19DA 120

PRODUC -R 11C0 118 120 120

QF -R 20DA 136 152

QM -R 21DA 136 144

RI -R 33= 34= 105 113 136 152

SUMDOS - 51SU 63SU 75SU 88SU 101SU 116SU 131SU 147SU 163SU

TDCR -R 30= 39= 105 119

UC ()R 3D1 26= 127

UCRAIN ()R 3D1 23DA 26 26 26 26

UHEAT ()R 3D1 24DA 28 28 28 28

UMILK ()R 3D1 23DA 27 27 27 27

UNK ()R 3D1 27= 143

UNT ()R 3D1 28= 159

UV ()R 3D1 29= 112

UVEC ()R 3D1 24DA 29 29 29 29

VL ()R 3D1 15DA

W -R 21DA 152 160

WC ()R 10C0 98 171=

WU ()R 3D1 13DA 98

XHEAT ()R 3D1 17DA 160

XMILK ()R 3D1 16DA

2 - 25D0 30*

5 - 42D0 44D0 46D0 52*

10 - 54D0 56D0 58D0 64*

15 - 66D0 68D0 70D0 76*

20 - 79D0 81D0 83D0 89*

25 - 92D0 94D0 96D0 102*

26 - 91 103*

30 - 106D0 108D0 110D0 117*

35 - 121D0 123D0 125D0 132*

36 - 118 133*

40 - 137D0 139D0 141D0 148*

41 - 134 149*

45 - 153D0 155D0 157D0 164*

50 - 31D0 150 165*

54 - 167D0 170*

55 - 166D0 172*

```
      1       SUBROUTINE SUMDOS( I, J, K, L, M, DOSE)
              C
              C*ABSTRACT: Finds the population dose or maximum individual dose.
              C
              C*AUTHOR: J STODDARD
              C
              C*TYPE: NUMERICAL ANALYSIS
              C
              C*PARAMETER DESCRIPTION:
              CIN       I - Subscript for isotope
              CIN       J - Subscript for distance increment.
              CIN       K - Subscript for pathway.
              CIN       L - Subscript for organ.
              CIN       M - Subscript for age group.
              CIN       DOSE - Dose for that pathway, organ, age group, distance
              C                increment using that isotope.
              C
              C*CALLED BY:
              C          BURYIT, OUTPUT, DOSET
              C
              C*CALLS TO:
              C          NONE
              C
              C*COMMON BLOCKS:
              CNAME       OUTD
              C            *dosei, *dosej, *dosek, *dosel, *dosem, *dosett
              CNAME       FDATA
              C            maxind
              C
              C*TECHNICAL DESCRIPTION:
              C             Finds the population dose or maximum individual dose by isotope(i),
              C             distance(j), pathway(k), organ(l), and age group(m).
              C           VARIABLE DESCRIPTIONS:
              C              DOSEI - Total dose by nuclide.
              C              DOSEJ - Total dose by distance increment.
              C              DOSEK - Total dose by pathway.
              C              DOSEL - Total dose by organ.
              C              DOSEM - Total dose by age group.
              C              DOSETT - Maximum individual dose or total dose depending on
              C                       maxind as set in input.
              C
      2           LOGICAL MAXIND
      3           DIMENSION DOSMI(20,3),BUFFER(27)
      4           COMMON/OUTD/ DOSEI(45),DOSEJ(20),DOSEK(9),DOSEL(9),
                +    DOSEM(3),DOSETT
      5           COMMON /FDATA/ CI(45),VD(45),WC(45),MAXIND
              C
      6           IF (I.GT.0) GO TO 35
              C     ZERO DOSE SUMS
      7           DOSETT = 0.
              C     ZERO SUMS BY ISOTOPE
      8           DO 5 NN = 1,45
      9           DOSEI(NN) = 0.
     10         5 CONTINUE
              C     ZERO SUMS BY DISTANCE
     11           DO 10 NN = 1,20
     12           DOSEJ(NN) = 0.
     13           DOSMI(NN,1) = 0.
```

```
      DOSMI(NN,2) = 0.
      DOSMI(NN,3) = 0.
   10 CONTINUE
C     ZERO SUMS BY PATHWAY
      DO 15 NN = 1,9
      DOSEK(NN) = 0.
   15 CONTINUE
C     ZERO SUMS BY ORGAN
      DO 20 NN = 1,9
      DOSEL(NN) = 0.
   20 CONTINUE
C     ZERO SUMS BY AGE GROUP
      DO 25 NN = 1,3
      DOSEM(NN) = 0.
   25 CONTINUE
      ID = 0
      IC = 0
      REWIND 20
      RETURN
C
   35 CONTINUE
      IF (MAXIND) GO TO 45
      IF (DOSE.LE.0.) RETURN
C     TOTALS FOR POPULATION DOSE
      IF (L.NE.1) GO TO 40
      DOSETT = DOSETT + DOSE
      DOSEI(I) = DOSEI(I) + DOSE
      DOSEJ(J) = DOSEJ(J) + DOSE
      DOSEM(M) = DOSEM(M) + DOSE
      DOSEK(K)=DOSEK(K) + DOSE
   40 DOSEL(L) = DOSEL(L) + DOSE
      RETURN
C     MAXIMUM INDIVIDUAL DOSE
   45 IF (J.LE.0) GO TO 55
      IF (DOSE.LT.0.) DOSE = 0.
      IF (L.NE.LORG) GO TO 50
C     CUMULATE WHOLE BODY DOSE FOR PERSON AT EACH AGE AND LOCATION
      DOSMI(J,M) = DOSMI(J,M) + DOSE
C     STORE DOSE DATA IN BUFFER LOCATION ID.  ID = (L-1)*NM+M
   50 ID = ID + 1
      BUFFER(ID) = DOSE
      IF (ID.LT.27) RETURN
C     STORE FILLED BUFFER ON SCRATCH FILE
      IC = IC + 1
      ID = 0
      WRITE (20) BUFFER,I,J,K
      RETURN
C     IDENTIFY MAXIMUM DOSE INDIVIDUAL AND CALCULATE HIS W.B. DOSE
   55 DOSETT = 0.
      DO 65 MM = 1,3
      DO 60 JJ = 1,20
      IF (DOSETT.GE.DOSMI(JJ,MM)) GO TO 60
      M = MM
      J = JJ
      DOSETT = DOSMI(J,M)
   60 CONTINUE
   65 CONTINUE
C     RETRIEVE DOSE DATA AND CUMULATE ORGAN DOSES, ISOTOPE AND PATH
```

```
      C     CONTRIBUTIONS.
            REWIND 20
            DO 75 II = 1,IC
            READ (20) BUFFER,I,JJ,K
            IF (JJ.NE.J) GO TO 75
            DOSEI(I) = DOSEI(I) + BUFFER(M)
            DOSEJ(J) = DOSEJ(J) + BUFFER(M)
            DOSEK(K) = DOSEK(K) + BUFFER(M)
            DO 70 L = 1,9
            LL = 3*(L-1) + M
            DOSEL(L) = DOSEL(L) + BUFFER(LL)
         70 CONTINUE
         75 CONTINUE
            RETURN
            END
```

SINGLY REFERENCED VARIABLES

C1 ()R 5CO FDATA - 5CN LOGICA - 2F OUTD - 4CN SUMDOS - 1SU WC ()R 5CO
DIMENS - 3F 11 -I 62DO LORG - -I 43 READ - 63F VD ()R WRITE - 50F

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUFFER | ()R | 3D1 | 46= | 50WR | 63RD | 65 | 66 | 67 | 70 | | | | | |
| COMMON | - | 4F | 5F | | | | | | | | | | | |
| DOSE | -R | 1AC | 32 | 34 | 35 | 36 | 37 | 38 | 39 | 42 | 42= | 44 | 46 | |
| DOSEI | ()R | 4CO | 9= | 35= | 35 | 65= | 65 | | | | | | | |
| DOSEJ | ()R | 4CO | 12= | 36= | 36 | 66= | 66 | | | | | | | |
| DOSEK | ()R | 4CO | 18= | 38= | 38 | 67= | 67 | | | | | | | |
| DOSEL | ()R | 4CO | 21= | 39= | 39 | 70= | 70 | | | | | | | |
| DOSEM | ()R | 4CO | 24= | 37= | 37 | | | | | | | | | |
| DOSETT | -R | 4CO | 7= | 34= | 34 | 52= | 55 | 58= | | | | | | |
| DOSMI | ()R | 3D1 | 13= | 14= | 15= | 44= | 44 | 55 | 58 | | | | | |
| I | -I | 1AC | 6 | 35 | 35 | 50WR | 63RD | 65 | 65 | | | | | |
| IC | -I | 27= | 48= | 48 | 62DO | | | | | | | | | |
| ID | -I | 26= | 45= | 45 | 46 | 47 | 49= | | | | | | | |
| IF | - | 6F | 31F | 32F | 33F | 41F | 42F | 43F | 47F | 55F | 64F | | | |
| J | -I | 1AC | 36 | 36 | 41 | 44 | 44 | 50WR | 57= | 58 | 64 | 66 | 66 | |
| JJ | -I | 54DO | 55 | 57 | 63RD | 64 | | | | | | | | |
| K | -I | 1AC | 38 | 38 | 50WR | 63RD | 67 | 67 | | | | | | |
| L | -I | 1AC | 33 | 39 | 39 | 43 | 68DO | 69 | 70 | 70 | | | | |
| LL | -I | 69= | 70 | | | | | | | | | | | |
| M | -I | 1AC | 37 | 37 | 44 | 44 | 56= | 58 | 65 | 66 | 67 | 69 | | |
| MAXIND | -L | 2LC | 5CO | 31 | | | | | | | | | | |
| MM | -I | 53DO | 55 | 56 | | | | | | | | | | |
| NN | -I | 8DO | 9 | 11DO | 12 | 13 | 14 | 15 | 17DO | 18 | 20DO | 21 | 23DO | 24 |
| RETURN | - | 29F | 32F | 40F | 47F | 51F | 73F | | | | | | | |
| REWIND | - | 28F | 61F | | | | | | | | | | | |
| 5 | - | 8DO | 10* | | | | | | | | | | | |
| 10 | - | 11DO | 16* | | | | | | | | | | | |
| 15 | - | 17DO | 19* | | | | | | | | | | | |
| 20 | - | 20DO | 22* | | | | | | | | | | | |
| 25 | - | 23DO | 25* | | | | | | | | | | | |
| 35 | - | 6 | 30* | | | | | | | | | | | |
| 40 | - | 33 | 39* | | | | | | | | | | | |
| 45 | - | 31 | 41* | | | | | | | | | | | |
| 50 | - | 43 | 45* | | | | | | | | | | | |
| 55 | - | 41 | 52* | | | | | | | | | | | |
| 60 | - | 54DO | 55 | 59* | | | | | | | | | | |
| 65 | - | 53DO | 60* | | | | | | | | | | | |
| 70 | - | 68DO | 71* | | | | | | | | | | | |
| 75 | - | 62DO | 64 | 72* | | | | | | | | | | |

```
1           FUNCTION EXPF(X)
            C
            C*ABSTRACT: Evaluation of exp(x)
            C
            C*AUTHOR: J STODDARD
            C
            C*TYPE: NUMERICAL ANALYSIS
            C
            C*PARAMETER DESCRIPTION:
            CIN       X - Variable for which exponential function will be applied.
            C
            C*CALLED BY:
            C           ATMOS, DINT, DOSET, DIRECT
            C*CALLS TO:
            C           NONE
            C
            C*TECHNICAL DESCRIPTION:
            C             Eliminates underflows and overflows in evaluating exp(x)
            C
2           EXPF = 0.
3           IF (X.LT.-60.) RETURN
4           EXPF = 1.E30
5           IF (X.GT.60.) RETURN
6           EXPF = EXP(X)
7           RETURN
8           END
```

SINGLY REFERENCED VARIABLES

| | | |
|---|---|---|
| EXP | - | 6SU |

MULTIPLY-REFERENCED VARIABLES

| | | | | | |
|---|---|---|---|---|---|
| EXPF | - | 1SU | 2= | 4= | 6= |
| IF | - | 3F | 5F | | |
| RETURN | - | 3F | 5F | 7F | |
| X | -R | 1AC | 3 | 5 | 6 |

```
      1       SUBROUTINE DIRECT
              C
              C*ABSTRACT: Calculates the external gamma dose.
              C
              C*AUTHOR: J STODDARD
              C
              C*TYPE: NUMERICAL ANALYSIS
              C
              C*CALLED BY:
              C         EXEC
              C
              C*CALLS TO:
              C         EXPF
              C
              C*COMMON BLOCKS:
              CNAME      MDATA
              C           is, r, ns, mat, thk, t, *dose, a
              CNAME      HYDRA
              C           k, ni, ci
              CNAME      NDATA
              C           ge
              C
              C*TECHNICAL DESCRIPTION:
              C           Calculates the external gamma dose from a point, line, or
              C           a volume source.
              C         VARIABLE DESCRIPTION:
              C           DOSE - Whole body exposure (roentgens)
              C
      2        COMMON/MDATA/IS,R,NS,MAT(5),THK(5),T,DOSE,A
      3        COMMON/HYDRA/ K,ND,IN,NI,DELW,RAIN,DRY,TIMWET,TIMDRY,DD(60),
             1 P(52),E(52),W(60),TIMINC,CONQ,HDRY,HWET,WATL,WATH,
             2 CONCOF(60),DNSTY(60),XD(45,60),SOLFAC(45),
             3 CI(45),CUMT,IPASS
      4        COMMON/NDATA/ DOSFAC(45,8,9),GE(45,10),IID(45)
      5        DIMENSION XMU(10,6),ALPHI(10,6),ALPH2(10,6),AI(10,6)
           C   CON = 4.*PI*100.*100.
      6        DATA CON/125663.7/
           C   TOTAL LINEAR ATTENUATION COEFFICIENTS, CM**-1
      7        DATA XMU/
             +   69.66,2.701,.437,.324,.227,.166,.117,.0956,.084,.0767,
             +   1352.,61.9,2.69,1.09,.652,.468,.334,.285,.260,.247,
             +   1452.,322.,59.3,10.7,1.746,.782,.510,.472,.469,.481,
             +   62.3,2.63,.400,.294,.204,.149,.105,.0852,.0744,.0677,
             +   4.99,.338,.160,.136,.0967,.0707,.0494,.0397,.034,.0303,
             +   5.81E-3,3.83E-4,1.82E-4,1.48E-4,1.048E-4,7.66E-5,5.36E-5,
             +   4.31E-5,3.71E-5, 3.31E-5/
           C    J.J.TAYLOR FORM BUILDUP COEFFICIENT DATA
      8        DATA AI/
             +    4*1.,38.911,18.782,16.981,10.583,7.526,6.620,
             +    4*1.,31.397,24.957,17.622,13.218,9.624,7.746,
             +    4*1.,1.677,2.984,5.421,5.500,3.897,2.412,
             +    4*1.,38.225,25.507,18.089,13.640,11.460,11.121,
             +    4*1.,100.845,19.601,12.612,11.110,11.163,9.774,
             +    10*1./
      9        DATA ALPHI/
             +    4*0.,-.10015,-.06020,-.04588,-.04066,-.03973,-.03954,
             +    4*0.,-.06842,-.06086,-.04627,-.04431,-.04698,-.05424,
             +    4*0.,-.03084,-.03503,-.03482,-.05422,-.08468,-.13164,
```

```
     +    4*0.,-.14024,-.07230,-.04250,-.03200,-.02660,-.02060,
     +    4*0.,-.12607,-.09037,-.05320,-.03550,-.02543,-.02182,
     +    10*0./
   10 DATA ALPH2/
     +    4*0.,-.06312,-.02973,.00271,.02514,.03860,.04104,
     +    4*0.,-.03742,-.02463,-.00526,-.00087,.00175,-.00006,
     +    4*0.,.30941,.13486,.04379,.00611,-.02383,-.03509,
     +    4*0.,-.10579,-.01843,.00049,.02022,.02450,.02688,
     +    4*0.,-.10925,-.02522,.01932,.03206,.03025,.03595,
     +    10*0./
C
C    STATEMENT FUNCTION FOR VOLUME SOURCE FACTOR
   11 FV(X)=X*X*((ATAN(1.-X)+ATAN(1.+X))+.5*((1.-X)*ALOG(1.+
     +    1./((1.-X)**2))+(1.+X)*ALOG(1.+1./((1.+X)**2))))
C
   12 IF (IABS(IS-2).GT.1) IS = 1
   13 DOSE = 1.E30
   14 IF (R.LT.1.E-3.AND.IS.NE.3) RETURN
   15 DOSE = 0.
   16 IF (T.LE.0.) RETURN
   17 IF (NI.LE.0) RETURN
C     SOURCE FORMULA MULTIPLIERS FOR POINT, LINE, VOLUME SOURCE
   18 GO TO (5,10,15),IS
   19  5 XM = T/(CON*R*R)
   20 GO TO 20
   21 10 XM = T*ATAN(A/R)/(CON*A*R)
   22 GO TO 20
   23 15 XM = T/(CON*R*R)
   24 B1=R/A
   25 IF(B1.LT.30.) XM=XM*FV(B1)
C     SUM DOSE OVER GAMMA ENERGY GROUPS
   26 20 DO 40 K = 1,10
C     SUM ATTENUATION AND BUILDUP FACTORS OVER NS SHIELDS
   27 SUM = XM
   28 TK = 0.
   29 IF (NS.LE.0.) GO TO 30
   30 DO 25 L = 1,NS
   31 M = MAT(L)
   32 TK = TK + THK(L)
   33 B1 = 100.*XMU(K,M)*THK(L)
   34 SUM = SUM * (AI(K,M)*EXPF(-ALPH1(K,M)*B1)+(1.-AI(K,M))*
     +       EXPF(-ALPH2(K,M)*B1))
   35 25 CONTINUE
C     SUM ATTENUATION AND BUILDUP FACTOR FOR AIR
   36 30 B1 = 100.*XMU(K,6)*(R-TK)
   37 SUM = SUM * (AI(K,6)*EXPF(-ALPH1(K,6)*B1)+(1.-AI(K,6))*
     +       EXPF(-ALPH2(K,6)*B1))
   38 DO 35 I=1,NI
   39 DOSE=CI(I)*GE(I,K)*SUM + DOSE
   40 35 CONTINUE
   41 40 CONTINUE
   42 RETURN
   43 END
```

SINGLY REFERENCED VARIABLES

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CORCOF | ()R | 3C0 | DIMENS | - | 5F | E | ()R | 3C0 | IID | ()I | 4C0 | NDATA | - | 4CN | TIMINC | -R | 3C0 | XD | ()R | 3C0 |
| CORQ | -R | 3C0 | DIRECT | - | 1SU | HDRY | -R | 3C0 | IN | -I | 3C0 | P | ()R | 3C0 | TIMWET | -R | 3C0 | | | |
| CORT | -R | 3C0 | DNSTY | ()R | 3C0 | HWET | -R | 3C0 | IPASS | -I | 3C0 | RAIN | -R | 3C0 | W | ()R | 3C0 | | | |
| DD | ()R | 3C0 | DOSFAC | ()R | 4C0 | HYDRA | - | 3CN | JDATA | - | 2CN | SOLFAC | ()R | 3C0 | WATH | -R | 3C0 | | | |
| DELW | -R | 3C0 | DRY | -R | 3C0 | IABS | - | 12SU | ND | -I | 3C0 | TIMDRY | -R | 3C0 | WATL | -R | 3C0 | | | |

MULTIPLY-REFERENCED VARIABLES

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | -R | 2C0 | 21 | 21 | 24 | | | | | | | |
| AI | ()R | 5D1 | 8DA | 34 | 34 | 37 | 37 | | | | | |
| ALOG | - | 11SU | 11SU | | | | | | | | | |
| ALPH1 | ()R | 5D1 | 9DA | 34 | 37 | | | | | | | |
| ALPH2 | ()R | 5D1 | 10DA | 34 | 37 | | | | | | | |
| ATAN | - | 11SU | 11SU | 21SU | | | | | | | | |
| BI | -R | 24* | 25 | 25 | 33* | 34 | 34 | 36* | 37 | 37 | | |
| CI | ()R | 3C0 | 39 | | | | | | | | | |
| COMMON | - | 2F | 3F | 4F | | | | | | | | |
| CON | -R | 6DA | 19 | 21 | 23 | | | | | | | |
| DATA | - | 6F | 7F | 8F | 9F | 10F | | | | | | |
| DOSE | -R | 2C0 | 13* | 15* | 39* | 39 | | | | | | |
| EXPF | - | 34SU | 34SU | 37SU | 37SU | | | | | | | |
| FV | - | 11SU | 25SU | | | | | | | | | |
| GE | ()R | 4C0 | 39 | | | | | | | | | |
| I | -I | 3BD0 | 39 | 39 | | | | | | | | |
| IF | - | 12F | 14F | 16F | 17F | 25F | 29F | | | | | |
| IS | -I | 2C0 | 12 | 12* | 14 | 18 | | | | | | |
| K | -I | 3C0 | 26D0 | 33 | 34 | 34 | 34 | 34 | 36 | 37 | 37 | 37 | 37 | 39 |
| L | -I | 30D0 | 31 | 32 | 33 | | | | | | | |
| N | -I | 31* | 33 | 34 | 34 | 34 | 34 | | | | | |
| NAT | ()I | 2C0 | 31 | | | | | | | | | |
| NI | -I | 3C0 | 17 | 38D0 | | | | | | | | |
| NS | -I | 2C0 | 29 | 30D0 | | | | | | | | |
| R | -R | 2C0 | 14 | 19 | 19 | 21 | 21 | 23 | 23 | 24 | 36 | |
| RETURN | - | 14F | 16F | 17F | 42F | | | | | | | |
| SUR | -R | 27* | 34* | 34 | 37* | 37 | 39 | | | | | |
| T | -R | 2C0 | 16 | 19 | 21 | 23 | | | | | | |
| TBK | ()R | 2C0 | 32 | 33 | | | | | | | | |
| TK | -R | 20* | 32* | 32 | 36 | | | | | | | |
| X | -R | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | | |
| XR | -R | 19* | 21* | 23* | 25* | 26 | 27 | | | | | |
| XRO | ()R | 5D1 | 7DA | 33 | 36 | | | | | | | |
| 5 | - | 18 | 19* | | | | | | | | | |
| 10 | - | 18 | 21* | | | | | | | | | |
| 15 | - | 18 | 23* | | | | | | | | | |
| 20 | - | 20 | 22 | 26* | | | | | | | | |
| 25 | - | 30D0 | 35* | | | | | | | | | |
| 30 | - | 29 | 36* | | | | | | | | | |
| 35 | - | 30D0 | 40* | | | | | | | | | |
| 40 | - | 26D0 | 41* | | | | | | | | | |

LIST OF ALL VARIABLES DEFINED IN INPUT
C MEANS VARIABLE WAS DEFINED IN COMMON IN THAT ROUTINE
D MEANS VARIABLE WAS DEFINED IN OTHER DECLARATIONS
NON-BLANK NUMERIC IS NUMBER OF NON-DECLARATORY REFERENCES
S PRECEDING MEANS SUBROUTINE(PROGRAM,FUNCTION) NAME
L PRECEDING MEANS COMMON(LCM) NAME
F PRECEDING MEANS FORTRAN KEYWORD
* PRECEDING MEANS VARIABLE IS DECLARED, NOT USED ANYWHERE

| VARIABLE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE | ROUTINE | TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | BURYIT | D | EXEC | D | INPUT | D | OUTPUT | D | UNSAT | 2D | FF10 | 10D | SUB2 | 3 | EROS10 | 1D | COMPUT | 1D |
| | LPRIME | 3 | VEC | 3 | INTER | 8D | FIN | 2 | ATMOS | D | SIGMAZ | 3CD | DIRECT | 5D | | | | |
| A1 | INPUT | D | OUTPUT | 2CD | FF10 | 3D | VEC | 2 | | | | | | | | | | |
| A2 | OUTPUT | 2CD | FF10 | 3D | | | | | | | | | | | | | | |
| A3 | FF10 | 3D | | | | | | | | | | | | | | | | |
| A4 | FF10 | 2D | | | | | | | | | | | | | | | | |
| S ABS | UNSAT | 17 | SUB2 | 2 | EROS10 | 2. | INTER | 2 | | | | | | | | | | |
| AC | EXEC | 1D | AQUIFR | 1D | FF10 | 4D | CNT | 1D | SWD | D | ATMOS | 1D | DOSET | 3D | | | | |
| ACT | EXEC | 1D | CNT | 2 | | | | | | | | | | | | | | |
| L ADS | UNSAT | 1 | ADSORB | 1 | | | | | | | | | | | | | | |
| S ADSORB | UNSAT | 1 | ADSORB | 1 | | | | | | | | | | | | | | |
| ACD | DOSET | 2C | | | | | | | | | | | | | | | | |
| A1 | DIRECT | 4CD | | | | | | | | | | | | | | | | |
| L ALL | BURYIT | 1 | EXEC | 1 | UNSAT | 1 | | | | | | | | | | | | |
| S ALOG | DINT | 2 | DIRECT | 2 | | | | | | | | | | | | | | |
| S ALOG10 | FIN | 3 | | | | | | | | | | | | | | | | |
| ALPH1 | DIRECT | 2CD | | | | | | | | | | | | | | | | |
| ALPH2 | DIRECT | 2CD | | | | | | | | | | | | | | | | |
| S AMAX1 | BURYIT | 1 | UNSAT | 1 | | | | | | | | | | | | | | |
| *AMT | AQUIFR | D | | | | | | | | | | | | | | | | |
| AN | FERRNT | 3D | | | | | | | | | | | | | | | | |
| AN1 | AQUIFR | 2D | | | | | | | | | | | | | | | | |
| ANC | BURYIT | D | EXEC | D | INPUT | D | EROS10 | 5D | COMPUT | 1D | LPRIME | 6 | ATMOS | D | | | | |
| ANCL | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | 2D | COMPUT | D | ATMOS | D | | | | | | |
| ANGWND | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | 1D | ATMOS | D | | | | | | | | |
| ANS | BURYIT | D | EXEC | D | INPUT | D | EROS10 | 6D | COMPUT | 7D | VEC | 2 | INTER | 4 | FIN | 6 | ATMOS | D |
| L AQUA | EXEC | 1 | INPUT | 1 | AQUIFR | 1 | FF10 | 1 | CNT | 1 | | | | | | | | |
| S AQUIFR | EXEC | 1 | AQUIFR | 1 | | | | | | | | | | | | | | |
| AREA | INPUT | 3D | ATMOS | D | DOSET | 4D | | | | | | | | | | | | |
| S ATAN | DIRECT | 3 | | | | | | | | | | | | | | | | |
| L ATM01 | INPUT | 1 | OUTPUT | 1 | UNSAT | 1 | EROS10 | 1 | ATMOS | 1 | DOSET | 1 | | | | | | |
| L ATM02 | EXEC | 1 | ATMOS | 1 | DOSET | 1 | | | | | | | | | | | | |
| S ATMOS | EXEC | 2 | ATMOS | 1 | | | | | | | | | | | | | | |
| AVEC | UNSAT | 2 | | | | | | | | | | | | | | | | |
| AV | ATMOS | 1CD | | | | | | | | | | | | | | | | |
| B | UNSAT | 36D | SUB2 | 5 | VEC | 8 | SIGMAZ | 3CD | | | | | | | | | | |
| B1 | DIRECT | 9 | | | | | | | | | | | | | | | | |
| BALANC | UNSAT | 2 | TRLIST | 2 | | | | | | | | | | | | | | |
| BB | UNSAT | 25 | | | | | | | | | | | | | | | | |
| BEEF | EXEC | D | INPUT | 1D | DOSET | 3D | | | | | | | | | | | | |
| BIV | PREDOS | 1D | DOSET | 1D | | | | | | | | | | | | | | |
| BN | FERRNT | 5D | | | | | | | | | | | | | | | | |
| BONDS | ADSORB | 13 | | | | | | | | | | | | | | | | |
| BOT | UNSAT | 3 | | | | | | | | | | | | | | | | |
| BR | DOSET | 2CD | | | | | | | | | | | | | | | | |
| BUFFER | SUBDOS | 7D | | | | | | | | | | | | | | | | |
| S BURYIT | BURYIT | 1 | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | UNSAT | 6D | SUM2 | 3 | VEC | 3 | SIGMAZ | 3CD | | | | | | | | | | | | |
| | C1 | FERRNT | 3D | | | | | | | | | | | | | | | | | | |
| F | CALL | BURYIT | 6 | EXEC | 12 | OUTPUT | 1 | UNSAT | 4 | AQUIFR | 1 | FF10 | 9 | SWD | 1 | EROS10 | 1 | COMPUT | 10 | | |
| | | LPRIME | 3 | IPRIME | 1 | KPRIME | 1 | VEC | 3 | DOSET | 9 | | | | | | | | | | |
| | CDLV | DOSET | 1C | | | | | | | | | | | | | | | | | | |
| | CFCT | INPUT | D | ADSORB | D | EROS10 | 1D | COMPUT | 1D | FLRH | 1D | ATMOS | D | | | | | | | | |
| | CHEC1 | INTER | 6 | | | | | | | | | | | | | | | | | | |
| | CHEC2 | INTER | 6 | | | | | | | | | | | | | | | | | | |
| | C1 | BURYIT | D | EXEC | 2D | OUTPUT | D | PREDOS | D | ATMOS | 2D | DOSET | D | SUMDOS | D | DIRECT | 1D | | | | |
| | C1MT | BURYIT | 1D | | | | | | | | | | | | | | | | | | |
| | C1N | EXEC | D | AQUIFR | 1D | FF10 | 1D | CNT | D | SWD | D | | | | | | | | | | |
| | CK1 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | IPRIME | 2 | ATMOS | D | | | | | | |
| | CK11 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| | CK19 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| | CK2 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | IPRIME | 3 | ATMOS | D | | | | | | |
| | CK3 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | KPRIME | 2 | ATMOS | D | | | | | | |
| | CK4 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | KPRIME | 2 | ATMOS | D | | | | | | |
| | CK5 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| | CK6 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| | CK8 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| | CK9 | BURYIT | D | EXEC | D | INPUT | 1D | EROS10 | D | COMPUT | 1D | ATMOS | D | | | | | | | | |
| F | CLOSE | BURYIT | 3 | INPUT | 6 | PREDOS | 1 | | | | | | | | | | | | | | |
| | CMWATB | UNSAT | 5 | TRLIST | 2 | | | | | | | | | | | | | | | | |
| F | COMMON | BURYIT | 7 | EXEC | 12 | INPUT | 8 | OUTPUT | 7 | PREDOS | 6 | UNSAT | 7 | ADSORB | 3 | FIXTIM | 2 | AQUIFR | 7 | | |
| | | FF10 | 3 | FERRNT | 1 | CNT | 9 | SWD | 1 | EROS10 | 5 | BLDATA | 1 | COMPUT | 2 | LPRIME | 1 | IPRIME | 1 | | |
| | | KPRIME | 1 | FLRH | 2 | VEC | 1 | ATMOS | 6 | DOSET | 8 | SUMDOS | 2 | DIRECT | 3 | | | | | | |
| S | COMPUT | EROS10 | 1 | COMPUT | 1 | | | | | | | | | | | | | | | | |
| | CON | DIRECT | 3C | | | | | | | | | | | | | | | | | | |
| | CONCOF | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 3D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | CONQ | BURYIT | D | EXEC | D | INPUT | D | OUTPUT | D | PREDOS | D | UNSAT | 6D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | CONS | FERRNT | 1CD | | | | | | | | | | | | | | | | | | |
| S | COS | EROS10 | 1 | | | | | | | | | | | | | | | | | | |
| | COWS | EXEC | D | INPUT | 1D | DOSET | 3D | | | | | | | | | | | | | | |
| | CROSS | FIN | 3CD | | | | | | | | | | | | | | | | | | |
| | CUBS | UNSAT | 5 | TRLIST | 2 | | | | | | | | | | | | | | | | |
| | CUBT | BURYIT | 7D | EXEC | 4D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 12D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | D | EXEC | 5D | OUTPUT | 1 | UNSAT | 16D | AQUIFR | D | CNT | D | SUM2 | 6 | SIGMAZ | 1CD | | | | | | |
| | DA | UNSAT | 10 | | | | | | | | | | | | | | | | | | |
| S | DABS | FERRNT | 2 | | | | | | | | | | | | | | | | | | |
| L | DAOUA | EXEC | 1 | UNSAT | 1 | FIXTIM | 1 | AQUIFR | 1 | | | | | | | | | | | | |
| F | DATA | BURYIT | 2 | INPUT | 1 | OUTPUT | 4 | PREDOS | 3 | UNSAT | 2 | AQUIFR | 3 | FERRNT | 3 | SWD | 1 | BLDATA | 10 | | |
| | | FIN | 2 | ATMOS | 1 | SIGMAZ | 4 | DINT | 5 | DOSET | 13 | DIRECT | 6 | | | | | | | | |
| | DAY | TRLIST | 2 | | | | | | | | | | | | | | | | | | |
| | DC | DOSET | 7D | | | | | | | | | | | | | | | | | | |
| | DCE | DOSET | 3 | | | | | | | | | | | | | | | | | | |
| | DCC | DOSET | 6 | | | | | | | | | | | | | | | | | | |
| | DCI | DOSET | 3 | | | | | | | | | | | | | | | | | | |
| | DCS | DOSET | 3 | | | | | | | | | | | | | | | | | | |
| | DD | BURYIT | D | EXEC | 2D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 37D | ADSORB | 0D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | DD1 | ADSORB | 3 | | | | | | | | | | | | | | | | | | |
| | DDD | EXEC | 1D | UNSAT | 2 | AQUIFR | 3D | CNT | D | | | | | | | | | | | | |
| | DDF | ATMOS | 2 | | | | | | | | | | | | | | | | | | |
| | DDR | ADSORB | 3 | | | | | | | | | | | | | | | | | | |
| | DDX | ADSORB | 3D | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PEC | UNSAT | 3D | ADSORB | 2D | | | | | | | | | | | | | | | | |
| | DELC | UNSAT | 2B | TRLIST | 3 | | | | | | | | | | | | | | | | |
| | DELTSV | UNSAT | 2 | | | | | | | | | | | | | | | | | | |
| | DELW | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 23D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | DERS | EXEC | 1D | EROSIO | 1D | | | | | | | | | | | | | | | | |
| | DERSE | INPUT | 2 | | | | | | | | | | | | | | | | | | |
| | DETT | UNSAT | 1D | TRLIST | 2 | I | | | | | | | | | | | | | | | |
| | DETTSV | UNSAT | 2 | | | | | | | | | | | | | | | | | | |
| S | DEXP | FERRNT | 2 | SUM2 | 4 | SWD | 1 | | | | | | | | | | | | | | |
| | DH | UNSAT | 2 | | | | | | | | | | | | | | | | | | |
| | DI | BURYIT | 2D | EXEC | 1D | UNSAT | D | | | | | | | | | | | | | | |
| | DIFF1 | FF10 | 6D | EROSIO | 5 | | | | | | | | | | | | | | | | |
| | DIFF2 | FF10 | 5D | EROSIO | 3 | | | | | | | | | | | | | | | | |
| | DIFFA | UNSAT | 4 | | | | | | | | | | | | | | | | | | |
| | DIFFB | UNSAT | 3 | | | | | | | | | | | | | | | | | | |
| F | DIRERS | BURYIT | 1 | INPUT | 1 | OUTPUT | 2 | PREDOS | 2 | UNSAT | 1 | ADSORB | 2 | BLDATA | 1 | INTER | 1 | FIN | 1 | | |
| | | ATMOS | 1 | SICHAZ | 1 | DINT | 1 | DOSET | 1 | SUMDOS | 1 | DIRECT | 1 | | | | | | | | |
| S | DINT | ATMOS | 1 | DINT | D | | | | | | | | | | | | | | | | |
| S | DIRECT | EXEC | 1 | DIRECT | 1 | | | | | | | | | | | | | | | | |
| | DLAM | AQUIFR | 2D | | | | | | | | | | | | | | | | | | |
| S | DLOC | SUM2 | 2 | | | | | | | | | | | | | | | | | | |
| | DLXA | UNSAT | 13 | | | | | | | | | | | | | | | | | | |
| | DLXB | UNSAT | 1D | | | | | | | | | | | | | | | | | | |
| | DM | FERRNT | 4D | | | | | | | | | | | | | | | | | | |
| | DRSTY | BURYIT | D | EXEC | 1D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | D | ADSORB | 3D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | DOSE | BURYIT | 2D | INPUT | D | OUTPUT | 2D | DOSET | 45 | SUMDOS | 12 | DIRECT | 4D | | | | | | | | |
| L | DOSEB | EXEC | 1 | INPUT | 1 | DOSET | 1 | | | | | | | | | | | | | | |
| | DOSEE | EXEC | 3D | UNSAT | 1D | FIXTIM | 9D | AQUIFR | 2D | | | | | | | | | | | | |
| | DOSEI | OUTPUT | 2D | SUMDOS | 5D | | | | | | | | | | | | | | | | |
| | DOSEJ | OUTPUT | 2D | SUMDOS | 5D | | | | | | | | | | | | | | | | |
| | DOSEK | OUTPUT | 2D | SUMDOS | 5D | | | | | | | | | | | | | | | | |
| | DOSEL | OUTPUT | 2D | SUMDOS | 5D | | | | | | | | | | | | | | | | |
| | DOSEM | OUTPUT | 2D | SUMDOS | 3D | | | | | | | | | | | | | | | | |
| S | DOSET | EXEC | 4 | DOSET | 1 | | | | | | | | | | | | | | | | |
| | DOSEIT | OUTPUT | 9D | SUMDOS | 6D | | | | | | | | | | | | | | | | |
| | DOSEX | EXEC | 1D | UNSAT | 1D | FIXTIM | 11D | AQUIFR | D | | | | | | | | | | | | |
| | DOSFAC | PREDOS | D | DOSET | 13D | DIRECT | D | | | | | | | | | | | | | | |
| | DOSMI | SUMDOS | 7D | | | | | | | | | | | | | | | | | | |
| F | DOUBLE | EXEC | 1 | AQUIFR | 1 | FF10 | 1 | FERRNT | 1 | CNT | 1 | SWD | 1 | | | | | | | | |
| | DRAS | UNSAT | 2D | ADSORB | 4D | | | | | | | | | | | | | | | | |
| | DRAW | UNSAT | 2D | ADSORB | 4D | | | | | | | | | | | | | | | | |
| | DRY | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 1D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| S | DSIGN | SUM2 | 2 | | | | | | | | | | | | | | | | | | |
| S | DSORT | FF10 | 4 | | | | | | | | | | | | | | | | | | |
| | DST | FLAM | 11 | | | | | | | | | | | | | | | | | | |
| | DTOT | AQUIFR | 4 | | | | | | | | | | | | | | | | | | |
| | DUM | FF10 | 4 | COMPUT | 5 | ATMOS | 10 | DOSET | 15 | | | | | | | | | | | | |
| | DUMF | ATMOS | 5 | | | | | | | | | | | | | | | | | | |
| | DUMW | ATMOS | 3 | | | | | | | | | | | | | | | | | | |
| | DUMSAT | UNSAT | 2D | | | | | | | | | | | | | | | | | | |
| | E | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 10D | ADSORB | D | FIXTIM | D | FF10 | 6D | | |
| | | SUM2 | 10 | VEC | 5 | ATMOS | D | DOSET | D | DIRECT | D | | | | | | | | | | |
| | E1 | EXEC | 2D | INPUT | 1D | AQUIFR | 1D | FF10 | 3D | CNT | D | | | | | | | | | | |
| | *EIK | FF10 | D | | | | | | | | | | | | | | | | | | |
| | E3 | FF10 | 3D | COMPUT | 3 | FLAM | 7 | | | | | | | | | | | | | | |

E3 FF10 5D COMPUT 3 FLRM 9
E4 FF10 2D COMPUT 3 FLRM 2 FIN 7
L EDATA PREDOS 1 DOSET 1
EERF11 FF10 2D
EERF12 FF10 1D
EERF21 FF10 3D
EERF22 FF10 2D
*EL2 AQUIFR CD
EOR UNSAT 19 TMLIST 5
F EQUIVA BLDATA 2 DINT 1
ER UNSAT 3
ERF FERRNT 7D
ERFC1 FERRNT 11D
ERFCM1 FF10 2D FERRNT 2D
EROD BLDATA CD LPRIME D IPRIME 1D KPRIME D FLRM D VEC D
L EROS EXEC 1 EROSIO 1 *
S EROSIO EXEC 1 EROSIO 1
ETA EXEC D AQUIFR 1D FF10 3D CNT D SWD D
EVAP UNSAT 4 TMLIST 3
S EXEC BURYIT 1 EXEC 1
S EXP EXPF 1
EXPC1 FERRNT 8D
EXPCM1 FF10 2D FERRNT 2D
S EXPF ATMOS 3 DINT 2 DOSET 6 EXPF 4 DIRECT 4
EXPMIN SWD 1C
F INPUT 1D OUTPUT D UNSAT 5D FERRNT 6D SUM2 7 EROSIO 2D ATMOS 1D DOSET D
F1 UNSAT D SIGMAZ 3
F10A1 SWD 3D
F10E1 SWD 5D
F2 SIGMAZ 2
FACTR FERRNT 8D
FACE EXEC D INPUT 1D DOSET 30D
FD DOSET 2C
L FDATA BURYIT 1 EXEC 1 OUTPUT 1 PREDOS 1 ATMOS 1 DOSET 1 SUMDOS 1
S FERRNT FF10 4 FERRNT 1
FF PREDOS 1D ATMOS 6 DOSET 2D
S FF10 FF10 1 SWD 1
L FFFFG EXEC 1 AQUIFR 1 FF10 1 CNT 1 SWD 1
FH DINT 3
FIDA FF10 4D
FIDE FF10 4D
S FIN COMPUT 2 FIN 1
S FIXTIM UNSAT 2 FIXTIM 1
FL BURYIT D EXEC 1D INPUT 3D EROSIO 2D COMPUT D ATMOS D
S FLOAT DOSET 3
FLOWR EXEC D INPUT 1D DOSET 2D
S FLRM COMPUT 1 FLRM 1
FN PREDOS 1D DOSET 2D
FN FERRNT 5D
FNM1 FERRNT 7D
FNM2 FERRNT 3D
FOUR FERRNT 2CD
FR BURYIT 2 INPUT 1D OUTPUT D UNSAT D EROSIO D ATMOS 6D DOSET D
FS DOSET 2C
S FV DIRECT 2
FVA EXEC D INPUT 1D DOSET 1D
FVC DOSET 1CD
FW BURYIT D EXEC 1D INPUT 3D EROSIO 2D COMPUT 1D LPRIME 5 ATMOS D

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FX | DINT | 4 | | | | | | | | | | | | | | | | |
| | C | UNSAT | 27D | SUM2 | 12 | | | | | | | | | | | | | | |
| | CC | EXEC | D | ATMOS | 1D | DOSET | 11D | | | | | | | | | | | | |
| | CE | PREDOS | D | DOSET | D | DIRECT | 1D | | | | | | | | | | | | |
| | CI | UNSAT | 4 | | | | | | | | | | | | | | | | |
| | CN | FERRNT | 6D | | | | | | | | | | | | | | | | |
| | CNM1 | FERRNT | 8D | | | | | | | | | | | | | | | | |
| | CNM2 | FERRNT | 3D | | | | | | | | | | | | | | | | |
| S | CNT | EXEC | 1 | CNT | 1 | | | | | | | | | | | | | | |
| | H | UNSAT | 51D | ATMOS | 4D | DINT | 3 | | | | | | | | | | | | |
| | HAFLIF | UNSAT | 2 | | | | | | | | | | | | | | | | |
| | HALF | PREDOS | 1D | UNSAT | 2D | AQUIFR | 1D | | | | | | | | | | | | |
| | HB | DINT | 4CD | | | | | | | | | | | | | | | | |
| L | HDATA | PREDOS | 1 | UNSAT | 1 | AQUIFR | 1 | DOSET | 1 | | | | | | | | | | |
| | HDRY | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 8D | ADSORB | D | FIXTIM | D | ATMOS | D |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| | HI | UNSAT | 5 | | | | | | | | | | | | | | | | |
| | HKP | UNSAT | 2 | | | | | | | | | | | | | | | | |
| | HL | DINT | 3 | | | | | | | | | | | | | | | | |
| | HT | INPUT | 1D | ADSORB | D | EROSIO | 1D | COMPUT | D | FLRM | D | | | | | | | | |
| | HTBR | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | 2D | COMPUT | 1D | LPRIME | 2 | ATMOS | D | | | | |
| | HWET | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 10D | ADSORB | D | FIXTIM | D | ATMOS | D |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| L | HYDRA | BURYIT | 1 | EXEC | 1 | INPUT | 1 | OUTPUT | 1 | PREDOS | 1 | UNSAT | 1 | ADSORB | 1 | FIXTIM | 1 | ATMOS | 1 |
| | | DOSET | 1 | DIRECT | 1 | | | | | | | | | | | | | | |
| | I | BURYIT | 54 | EXEC | 34 | INPUT | 32 | OUTPUT | 59 | PREDOS | 2 | UNSAT | 99 | ADSORB | 13 | FIXTIM | 40 | AQUIFR | 7 |
| | | CNT | 6 | EROSIO | 17 | LPRIME | 7 | IPRIME | 3 | FLRM | 28 | VEC | 8 | INTER | 5 | FIN | 8 | ATMOS | 12 |
| | | SIGMAZ | 5 | DINT | 17 | DOSET | 45 | SUMDOS | 8 | DIRECT | 3 | | | | | | | | |
| | IA | EXEC | 3 | | | | | | | | | | | | | | | | |
| | IABOVE | FLRM | 8 | | | | | | | | | | | | | | | | |
| S | IABS | UNSAT | 1 | DIRECT | 1 | | | | | | | | | | | | | | |
| | IACE | OUTPUT | 2CD | | | | | | | | | | | | | | | | |
| | IB | EXEC | 3 | | | | | | | | | | | | | | | | |
| | IBAOVE | FLRM | 2 | | | | | | | | | | | | | | | | |
| | IBELOW | FLRM | 9 | | | | | | | | | | | | | | | | |
| | IBHND | FLRM | 12 | | | | | | | | | | | | | | | | |
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| F | IF | BURYIT | 29 | EXEC | 23 | INPUT | 8 | OUTPUT | 25 | PREDOS | 6 | UNSAT | 94 | TMLIST | 3 | ADSORB | 14 | FIXTIM | 10 |
| | | AQUIFR | 3 | FF10 | 6 | FERRNT | 11 | SUM2 | 10 | SWD | 4 | EROSIO | 14 | COMPUT | 6 | LPRIME | 3 | IPRIME | 5 |
| | | KPRIME | 4 | FLRM | 11 | VEC | 7 | INTER | 8 | FIN | 7 | ATMOS | 10 | SIGMAZ | 4 | DINT | 4 | DOSET | 32 |
| | | SUMDOS | 10 | EXPF | 2 | DIRECT | 6 | | | | | | | | | | | | |
| | IFLAG | OUTPUT | 4 | | | | | | | | | | | | | | | | |
| | IFRNT | FLRM | 10 | | | | | | | | | | | | | | | | |
| | IH | BURYIT | 5 | | | | | | | | | | | | | | | | |
| | IHS | BURYIT | 2CD | | | | | | | | | | | | | | | | |
| | IHT | BURYIT | 2D | | | | | | | | | | | | | | | | |
| | II | BURYIT | 12 | EXEC | 2 | AQUIFR | 2 | DINT | 2 | DOSET | 10 | SUMDOS | 1 | | | | | | |
| | IID | PREDOS | 1D | DOSET | 1D | DIRECT | D | | | | | | | | | | | | |
| | IJ | EXEC | 2 | AQUIFR | 2 | | | | | | | | | | | | | | |
| | IK | EXEC | 8 | | | | | | | | | | | | | | | | |
| | IL | BURYIT | 2 | | | | | | | | | | | | | | | | |

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| | IN | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 6D | ADSORB | 2D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | INIT | IPRIME | 2 | | | | | | | | | | | | | | | | | | |
| S | INPUT | EXEC | 1 | INPUT | 1 | | | | | | | | | | | | | | | | |
| S | INT | THLIST | 2 | | | | | | | | | | | | | | | | | | |
| F | INTEGE | FIN | 1 | | | | | | | | | | | | | | | | | | |
| | INTER | BURYIT | 6D | UNSAT | 1D | LPRIME | 3 | IPRIME | 1 | KPRIME | 1 | VEC | 3 | INTER | 1 | | | | | | |
| | INVET | BURYIT | 3 | | | | | | | | | | | | | | | | | | |
| | INVS | BURYIT | 1CD | | | | | | | | | | | | | | | | | | |
| | IORG | OUTPUT | 2CD | | | | | | | | | | | | | | | | | | |
| | IP | EXEC | 1D | DOSET | 14D | | | | | | | | | | | | | | | | |
| | IPASS | BURYIT | D | EXEC | 1D | OUTPUT | D | PREDOS | D | UNSAT | D | ADSORB | 3D | FIXTIM | D | ATMOS | D | DOSET | D | | |
| | | DIRECT | D | | | | | | | | | | | | | | | | | | |
| | IPATH | BURYIT | 4 | OUTPUT | 2CD | | | | | | | | | | | | | | | | |
| | IPATHS | BURYIT | 6D | | | | | | | | | | | | | | | | | | |
| | IPATHZ | BURYIT | 2D | EXEC | D | UNSAT | D | | | | | | | | | | | | | | |
| | IPOP | INPUT | 1D | | | | | | | | | | | | | | | | | | |
| S | IPRIME | COMPUT | 1 | IPRIME | 1 | | | | | | | | | | | | | | | | |
| | IPRNT | BURYIT | 1D | EXEC | 11D | INPUT | D | OUTPUT | D | PREDOS | D | UNSAT | 8D | AQUIFR | 1D | EROSIO | 1D | | | | |
| | IPZ | BURYIT | 12 | EXEC | 10 | INPUT | 51 | | | | | | | | | | | | | | |
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| | ISW | INPUT | 2 | | | | | | | | | | | | | | | | | | |
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| | ITI | EXEC | 2D | | | | | | | | | | | | | | | | | | |
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| | ITAB | UNSAT | 4 | | | | | | | | | | | | | | | | | | |
| | ITI | BURYIT | 3 | | | | | | | | | | | | | | | | | | |
| | ITITLE | BURYIT | 2D | EXEC | D | INPUT | D | OUTPUT | 4D | PREDOS | D | UNSAT | D | AQUIFR | D | EROSIO | D | | | | |
| | ITNUM | FIXTIM | 17 | | | | | | | | | | | | | | | | | | |
| | ITS | EXEC | 2D | UNSAT | 6D | | | | | | | | | | | | | | | | |
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| | IVOL | BURYIT | 3 | | | | | | | | | | | | | | | | | | |
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| | IYEAR | THLIST | 3 | | | | | | | | | | | | | | | | | | |
| | IZ | SUM2 | 4 | | | | | | | | | | | | | | | | | | |
| | J | BURYIT | 18 | EXEC | 19 | INPUT | 4 | OUTPUT | 16 | PREDOS | 6 | UNSAT | 99 | FIXTIM | 10 | AQUIFR | 7 | CNT | 8 | | |
| | | EROSIO | 7 | FLRM | 4 | VEC | 12 | INTER | 10 | ATMOS | 9 | DINT | 14 | DOSET | 51 | SUMDOS | 12 | | | | |
| | JJ | PREDOS | 1 | FIXTIM | 7 | DINT | 2 | DOSET | 18 | SUMDOS | 5 | | | | | | | | | | |
| | JK | BURYIT | D | EXEC | D | INPUT | 2D | OUTPUT | D | PREDOS | D | CNT | 5 | DOSET | D | | | | | | |
| | JKL | PREDOS | 2 | | | | | | | | | | | | | | | | | | |
| | JN | EXEC | 2 | | | | | | | | | | | | | | | | | | |
| | JOUT | FIXTIM | 14 | | | | | | | | | | | | | | | | | | |
| | JT | UNSAT | 2 | | | | | | | | | | | | | | | | | | |
| | K | BURYIT | 14 | EXEC | 12 | OUTPUT | 1 | PREDOS | 8 | UNSAT | 12D | ADSORB | D | FIXTIM | 31 | AQUIFR | 2 | INTER | 7 | | |
| | | ATMOS | D | SUMDOS | 7 | DIRECT | 12D | | | | | | | | | | | | | | |
| | KC | UNSAT | 12 | | | | | | | | | | | | | | | | | | |
| | KCK | UNSAT | 8 | | | | | | | | | | | | | | | | | | |
| | KK | INPUT | 4 | PREDOS | 13 | UNSAT | 14D | DOSET | 18 | | | | | | | | | | | | |
| | KLSP | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | D | COMPUT | 1D | IPRIME | 3D | ATMOS | D | | | | | | |
| | *KNUM | FIXTIM | D | | | | | | | | | | | | | | | | | | |
| S | KPRIME | COMPUT | 1 | KPRIME | 1 | | | | | | | | | | | | | | | | |
| | KS | INPUT | 1D | OUTPUT | D | UNSAT | D | EROSIO | D | ATMOS | 4D | DOSET | D | | | | | | | | |
| | KT | AQUIFR | 3 | | | | | | | | | | | | | | | | | | |
| | L | BURYIT | 11 | INPUT | 4 | OUTPUT | 1 | UNSAT | 3 | FIXTIM | 10 | FLRM | 10 | VEC | 2 | INTER | 1 | ATMOS | 13 | | |
| | | SIGMAZ | 12 | DOSET | 31 | SUMDOS | 9 | DIRECT | 4 | | | | | | | | | | | | |

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| | L100 | FIXTIM | 5 | | | | | | | | | | | | | | | | |
| L | LDATA | BURYIT | 1 | OUTPUT | 1 | | | | | | | | | | | | | | |
| | LL | BURYIT | 2 | UNSAT | 3 | ADSORB | 4 | FIXTIM | 7 | DOSET | 18 | SUMDOS | 2 | | | | | | |
| F | LOGICA | BURYIT | 1 | EXEC | 1 | OUTPUT | 1 | PREDOS | 1 | SWD | 1 | ATMOS | 1 | DOSET | 1 | SUMDOS | 1 | | |
| | LORG | SUMDOS | 1 | | | | | | | | | | | | | | | | |
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| | MAXIND | BURYIT | 2D | EXEC | D | OUTPUT | 24D | PREDOS | D | ATMOS | 2D | DOSET | 21D | SUMDOS | 1D | | | | |
| | MAXTIM | EROSIO | 3D | COMPUT | D | IPRIME | D | | | | | | | | | | | | |
| I. | MDATA | BURYIT | 1 | INPUT | 1 | OUTPUT | 1 | DIRECT | 1 | | | | | | | | | | |
| | MM | INTER | 2 | ATMOS | 2 | DOSET | 18 | SUMDOS | 3 | | | | | | | | | | |
| | MONTH | TMLIST | 3 | | | | | | | | | | | | | | | | |
| | M | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | D | ADSORB | 27D | AQUIFR | D | EROSIO | D |
| | | INTER | 8 | | | | | | | | | | | | | | | | |
| | NAME | BURYIT | 3D | EXEC | 1D | INPUT | D | OUTPUT | 2D | PREDOS | 9D | UNSAT | 2D | AQUIFR | 1D | EROSIO | 1D | | |
| | NAMEJ | PREDOS | 3D | | | | | | | | | | | | | | | | |
| | NB | UNSAT | 10 | | | | | | | | | | | | | | | | |
| | NBC | FERRNT | 1C | | | | | | | | | | | | | | | | |
| | NBM | FERRNT | 1C | | | | | | | | | | | | | | | | |
| | NCPY | EXEC | D | INPUT | 1D | DOSET | 3D | | | | | | | | | | | | |
| | ND | BURYIT | D | EXEC | D | INPUT | 3D | OUTPUT | D | PREDOS | D | UNSAT | 14D | ADSORB | D | FIXTIM | D | ATMOS | 1CD |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| L | NDATA | PREDOS | 1 | DOSET | 1 | DIRECT | 1 | | | | | | | | | | | | |
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| | NDLTNM | UNSAT | 3 | | | | | | | | | | | | | | | | |
| | NE | UNSAT | 6 | | | | | | | | | | | | | | | | |
| L | NEGXER | FF10 | 1 | FERRNT | 1 | | | | | | | | | | | | | | |
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| | NHI | UNSAT | 3 | | | | | | | | | | | | | | | | |
| | NI | ATMOS | 2D | DOSET | 2D | DIRECT | 2D | | | | | | | | | | | | |
| | NIN | BURYIT | 6 | | | | | | | | | | | | | | | | |
| | NJ | OUTPUT | 3D | DOSET | 10D | | | | | | | | | | | | | | |
| | NL | DOSET | 9C | | | | | | | | | | | | | | | | |
| | NLO | UNSAT | 4 | | | | | | | | | | | | | | | | |
| | NM | DOSET | 10C | | | | | | | | | | | | | | | | |
| | NN | PREDOS | 2D | SUMDOS | 13 | | | | | | | | | | | | | | |
| | NO | BURYIT | 14 | | | | | | | | | | | | | | | | |
| | NOWCNT | UNSAT | 4 | | | | | | | | | | | | | | | | |
| | NR | INPUT | 6D | ATMOS | 1D | | | | | | | | | | | | | | |
| | NRHI | INPUT | 3 | | | | | | | | | | | | | | | | |
| | NS | BURYIT | 2 | EXEC | 2 | INPUT | 1D | OUTPUT | D | UNSAT | D | AQUIFR | 3 | CNT | 3 | EROSIO | D | ATMOS | 1D |
| | | DOSET | D | DIRECT | 2D | | | | | | | | | | | | | | |
| | NS3 | CNT | 5 | | | | | | | | | | | | | | | | |
| | NSH | BURYIT | D | INPUT | 3D | | | | | | | | | | | | | | |
| | NSS | INPUT | 2D | OUTPUT | D | UNSAT | D | EROSIO | 1D | ATMOS | 3D | DOSET | D | | | | | | |
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| | NO | BURYIT | D | EXEC | D | INPUT | 4D | EROSIO | 1D | COMPUT | D | ATMOS | 2D | | | | | | | | |
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| | NUM | UNSAT | 2 | | | | | | | | | | | | | | | | | | |
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| | ONE | FERRNT | 12CD | | | | | | | | | | | | | | | | | | |
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| | ORICNT | BURYIT | 2D | EXEC | 2D | INPUT | D | OUTPUT | D | PREDOS | D | UNSAT | 2D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | | | | | | | | | | | | | | | | | | |
| L | OUTD | OUTPUT | 1 | SUMDOS | 1 | | | | | | | | | | | | | | | | |
| S | OUTPUT | BURYIT | 2 | OUTPUT | 1 | | | | | | | | | | | | | | | | |
| | P | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 43D | ADSORB | D | FIXTIM | D | FF10 | 5D | | |
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| | P2 | FLRM | 8 | | | | | | | | | | | | | | | | | | |
| | P3 | FLRM | 2 | | | | | | | | | | | | | | | | | | |
| | P4 | FLRM | 2 | | | | | | | | | | | | | | | | | | |
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| | PARTSL | UNSAT | 2D | | | | | | | | | | | | | | | | | | |
| | PBIV | PREDOS | 1CD | | | | | | | | | | | | | | | | | | |
| | PEC | EXEC | D | AQUIFR | 1D | CNT | D | | | | | | | | | | | | | | |
| | PFF | PREDOS | 1CD | | | | | | | | | | | | | | | | | | |
| | PFM | PREDOS | 1CD | | | | | | | | | | | | | | | | | | |
| | PI | INPUT | 3C | AQUIFR | 1CD | COMPUT | 2 | IPRIME | 2 | | | | | | | | | | | | |
| | PIT | UNSAT | 5 | TMLIST | 2 | | | | | | | | | | | | | | | | |
| | PK | COMPUT | 2 | KPRIME | 5 | | | | | | | | | | | | | | | | |
| | PK1 | LPRIME | 3 | | | | | | | | | | | | | | | | | | |
| | PK2 | LPRIME | 2 | | | | | | | | | | | | | | | | | | |
| | PK50 | LPRIME | 3 | | | | | | | | | | | | | | | | | | |
| | PL | COMPUT | 2 | LPRIME | 2 | FLRM | 7 | | | | | | | | | | | | | | |
| | POOL | DOSET | 1C | | | | | | | | | | | | | | | | | | |
| | POT | UNSAT | 3 | | | | | | | | | | | | | | | | | | |
| S | PREDOS | BURYIT | 1 | PREDOS | 1 | | | | | | | | | | | | | | | | |
| | PREV | FERRNT | 5D | | | | | | | | | | | | | | | | | | |
| | PRODUC | EXEC | D | INPUT | 1D | DOSET | 3D | | | | | | | | | | | | | | |
| | PWR | FERRNT | 2D | | | | | | | | | | | | | | | | | | |
| | Q | UNSAT | 12D | ADSORB | 4D | | | | | | | | | | | | | | | | |
| | Q1 | UNSAT | 2 | TMLIST | 2 | | | | | | | | | | | | | | | | |
| | Q90T | UNSAT | 3D | ADSORB | 2D | | | | | | | | | | | | | | | | |
| | QF | DOSET | 2C | | | | | | | | | | | | | | | | | | |
| | QH | DOSET | 2C | | | | | | | | | | | | | | | | | | |
| | R | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | AQUIFR | 1D | FF10 | 1D | CNT | D | SWD | D | EROSIO | 3D | | |
| | | COMPUT | 4D | VEG | 14 | INTER | 2 | ATMOS | D | DIRECT | 9D | | | | | | | | | | |
| | *R1 | EXEC | D | | | | | | | | | | | | | | | | | | |
| | RA2TOT | UNSAT | 7D | | | | | | | | | | | | | | | | | | |
| | RAIN | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 1D | ADSORB | D | FIXTIM | D | ATMOS | D | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | |
| | RANGE | BURYIT | D | INPUT | 1D | | | | | | | | | | | | | | | | |
| | RANGL1 | EROSIO | 2 | | | | | | | | | | | | | | | | | | |
| | RANGL2 | EROSIO | 5 | | | | | | | | | | | | | | | | | | |
| | RAS | UNSAT | 1D | ADSORB | 7D | | | | | | | | | | | | | | | | |
| | RAW | UNSAT | 1D | ADSORB | 14D | | | | | | | | | | | | | | | | |
| | RAWCON | ADSORB | 8D | | | | | | | | | | | | | | | | | | |
| | RBOTTH | UNSAT | 2 | ADSORB | 2D | | | | | | | | | | | | | | | | |
| | RC | ATMOS | 4 | | | | | | | | | | | | | | | | | | |
| | RDCHT | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | 2D | COMPUT | 1D | KPRIME | 3 | ATMOS | D | | | | | | |
| | RDCRCH | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | D | COMPUT | 1D | KPRIME | 4 | ATMOS | D | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RDCSP | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | 2D | COMPUT | 1D | KPRIME | 3 | ATMOS | D | | | | | | | | |
| F | READ | BURYIT | 19 | INPUT | 25 | PREDOS | 2 | UNSAT | 1 | SUMDOS | 1 | | | | | | | | | | | | |
| F | REAL | INPUT | 1 | UNSAT | 1 | EROSIO | 2 | COMPUT | 1 | IPRIME | 1 | ATMOS | 1 | | | | | | | | | | |
| | RENTER | UNSAT | 4D | | | | | | | | | | | | | | | | | | | | |
| F | RETURN | EXEC | 8 | INPUT | 4 | OUTPUT | 2 | PREDOS | 1 | UNSAT | 1 | TMLIST | 1 | ADSORB | 1 | FIXTIM | 4 | AQUIFR | 1 | | | | |
| | | FF10 | 1 | FERRNT | 1 | CNT | 1 | SUM2 | 6 | SWD | 2 | EROSIO | 1 | COMPUT | 3 | LPRIME | 1 | IPRIME | 1 | | | | |
| | | KPRIME | 4 | FLRM | 1 | VEC | 2 | INTER | 3 | FIN | 4 | ATMOS | 1 | SIGMAZ | 1 | DINT | 3 | DOSET | 1 | | | | |
| | | SUMDOS | 6 | EXPF | 3 | DIRECT | 4 | | | | | | | | | | | | | | | | |
| F | REWIND | SUMDOS | 2 | | | | | | | | | | | | | | | | | | | | |
| | RF | INPUT | D | OUTPUT | D | UNSAT | 1D | EROSIO | 1D | ATMOS | 2D | DOSET | D | | | | | | | | | | |
| | RHO | INPUT | D | ADSORB | 1D | EROSIO | 2D | COMPUT | D | FLRM | D | | | | | | | | | | | | |
| | RI | INPUT | 5 | DOSET | 6 | | | | | | | | | | | | | | | | | | |
| | RM | INPUT | 5D | OUTPUT | 4D | ATMOS | 6D | DOSET | D | | | | | | | | | | | | | | |
| | RNBC | FERRNT | 3D | | | | | | | | | | | | | | | | | | | | |
| | RNCLD | UNSAT | 4D | ADSORB | 23D | | | | | | | | | | | | | | | | | | |
| | RNW | AQUIFR | 2D | | | | | | | | | | | | | | | | | | | | |
| | RNWV | EXEC | 1D | INPUT | 1D | AQUIFR | 1D | FF10 | D | CNT | D | | | | | | | | | | | | |
| | RO | INPUT | 5 | | | | | | | | | | | | | | | | | | | | |
| | RPASS | ADSORB | 15 | | | | | | | | | | | | | | | | | | | | |
| | RPOWER | UNSAT | 3 | | | | | | | | | | | | | | | | | | | | |
| | RROUGH | BLDATA | CD | LPRIME | D | IPRIME | D | KPRIME | 1D | FLRM | D | VEC | D | | | | | | | | | | |
| | S | LPRIME | 2 | IPRIME | 2 | | | | | | | | | | | | | | | | | | |
| | S1 | CNT | 3D | | | | | | | | | | | | | | | | | | | | |
| | SAIR | BURYIT | D | EXEC | D | INPUT | 1D | EROSIO | 4D | COMPUT | D | ATMOS | D | | | | | | | | | | |
| | SCALE | BLDATA | CD | LPRIME | D | IPRIME | D | KPRIME | D | FLRM | 10D | VEC | D | | | | | | | | | | |
| | SCF | FERRNT | 5D | | | | | | | | | | | | | | | | | | | | |
| | SCL | FF10 | 5D | | | | | | | | | | | | | | | | | | | | |
| | SCLT | FF10 | 1D | | | | | | | | | | | | | | | | | | | | |
| | SENTER | UNSAT | 7D | ADSORB | 1D | | | | | | | | | | | | | | | | | | |
| | SFR | BURYIT | 4D | | | | | | | | | | | | | | | | | | | | |
| | SH | INPUT | 1D | ATMOS | 4D | DOSET | D | | | | | | | | | | | | | | | | |
| | SI | IPRIME | 3 | | | | | | | | | | | | | | | | | | | | |
| S | SIGMAY | ATMOS | 2 | | | | | | | | | | | | | | | | | | | | |
| S | SIGMAZ | ATMOS | 1 | SIGMAZ | 7 | | | | | | | | | | | | | | | | | | |
| | SIGZ | ATMOS | 3 | | | | | | | | | | | | | | | | | | | | |
| S | SIN | EROSIO | 1 | | | | | | | | | | | | | | | | | | | | |
| | SINF | UNSAT | 5 | TMLIST | 2 | | | | | | | | | | | | | | | | | | |
| | SOIL | UNSAT | 3 | | | | | | | | | | | | | | | | | | | | |
| | SOLFAC | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 4D | ADSORB | D | FIXTIM | D | ATMOS | D | | | | |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | | | | | |
| | SOLLSS | BLDATA | D | LPRIME | D | IPRIME | D | KPRIME | D | FLRM | 30D | VEC | D | | | | | | | | | | |
| | SORPFC | ADSORB | 4 | | | | | | | | | | | | | | | | | | | | |
| | SQ | INPUT | 1D | ATMOS | 1D | DOSET | D | | | | | | | | | | | | | | | | |
| F | STOP | BURYIT | 5 | PREDOS | 2 | UNSAT | 11 | FIXTIM | 1 | | | | | | | | | | | | | | |
| | SUM | FERRNT | 4D | EROSIO | 4 | ATMOS | 4 | DIRECT | 6 | | | | | | | | | | | | | | |
| | SUM0 | ATMOS | 4 | | | | | | | | | | | | | | | | | | | | |
| | SUM1 | UNSAT | 10 | TMLIST | 3 | | | | | | | | | | | | | | | | | | |
| | SUM2 | UNSAT | 6 | FF10 | 5 | SUM2 | 1 | | | | | | | | | | | | | | | | |
| | SUM3 | UNSAT | 6 | | | | | | | | | | | | | | | | | | | | |
| S | SUMDOS | BURYIT | 2 | OUTPUT | 1 | DOSET | 9 | SUMDOS | 1 | | | | | | | | | | | | | | |
| | SUMF | ATMOS | 4 | | | | | | | | | | | | | | | | | | | | |
| | SUMG | EROSIO | 6 | | | | | | | | | | | | | | | | | | | | |
| | SUMT1 | FF10 | 2D | | | | | | | | | | | | | | | | | | | | |
| | SUMT2 | FF10 | 2D | | | | | | | | | | | | | | | | | | | | |
| | SUMW | ATMOS | 4 | | | | | | | | | | | | | | | | | | | | |
| | SUMMAT | UNSAT | 10D | | | | | | | | | | | | | | | | | | | | |
| | *SW | BLDATA | CD | | | | | | | | | | | | | | | | | | | | |
| S | SWD | AQUIFR | 1 | SWD | 1 | | | | | | | | | | | | | | | | | | |

SWDI AQUIFR 5D SWD 3D
*SX BLDATA CD
*SY BLDATA CD
*SZ BLDATA CD
T EXEC 3D OUTPUT D UNSAT 23D AQUIFR 1D FF10 6D CNT 5D DOSET 1 DIRECT 4D
TI EXEC 8D INPUT D AQUIFR 1D CNT D
TA IPRIME 2
TA1 OUTPUT 3
TA2 OUTPUT 3
TAA UNSAT 3C
TANN FIN 3CD
TBB UNSAT 2
TDCN DOSET 4
TDOSE BURYIT 1D OUTPUT 3D
TDOSEI BURYIT 1D OUTPUT 3D
TDOSEJ BURYIT 1D OUTPUT 3D
TDOSEK BURYIT 1D OUTPUT 3D
TDOSEL BURYIT 1D OUTPUT 3D
TDOSEM BURYIT 1D OUTPUT 3D
TDOSEP BURYIT 1D OUTPUT 4D
*TE INPUT D
TE3 FLRM 2
TEMP FIXTIM 4
TERF11 FF10 2D
TERF12 FF10 1D
TERF21 FF10 3D
TERF22 FF10 2D
THETA EXEC D AQUIFR 2D FF10 7D CNT D SWD 1D
THK BURYIT D INPUT 1D OUTPUT D DIRECT 2D
THRSHD AQUIFR 1CD
THSUBR EROSIO 4
TI FIXTIM 14D
TIA EXEC 6D UNSAT 2D FIXTIM 12D AQUIFR D
TIM EXEC 2D
TIMDRY BURYIT D EXEC D INPUT 2D OUTPUT D PREDOS D UNSAT 3D ADSORB D FIXTIM D ATMOS D
DOSET D DIRECT D
TIME EXEC 7 UNSAT 21 TMLIST 4 EROSIO 2D
TIMING BURYIT D EXEC D INPUT D OUTPUT D PREDOS D UNSAT 3D ADSORB D FIXTIM D ATMOS D
DOSET D DIRECT D
TIMWET BURYIT D EXEC D INPUT 2D OUTPUT D PREDOS D UNSAT 2D ADSORB D FIXTIM D ATMOS D
DOSET D DIRECT D
TIS EXEC 3D UNSAT 2D
TK DIRECT 4
TL SUM2 5
TL1 FF10 3D
TL2 FF10 3D
TM UNSAT 15
S TMLIST UNSAT 1 TMLIST 1
TN FERRNT 5D
TOLER FERRNT 3D
TOP UNSAT 3
TOTRAS UNSAT 1D ADSORB 3D
TOTRAW UNSAT 1D ADSORB 3D
TR SUM2 5
TR1 FF10 3D
TR2 FF10 3D
TRAS UNSAT 8
TRAW UNSAT 8

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TRR | OUTPUT | 3 | | | | | | | | | | | | | | | | |
| | TRRGLD | UNSAT | 8 | | | | | | | | | | | | | | | | |
| | TRRTPI | FERRNT | 2CD | | | | | | | | | | | | | | | | |
| | TSOL | UNSAT | 4 | | | | | | | | | | | | | | | | |
| L | TSTEP | EXEC | 1 | AQUIFR | 1 | CNT | 1 | | | | | | | | | | | | |
| | TT | UNSAT | 17C | FF10 | 1D | CNT | 4 | | | | | | | | | | | | |
| | TW | UNSAT | 19 | | | | | | | | | | | | | | | | |
| | TWO | FERRNT | 12CD | | | | | | | | | | | | | | | | |
| | TWW | UNSAT | 9 | | | | | | | | | | | | | | | | |
| | TZ | EXEC | 6D | INPUT | 1D | AQUIFR | 2D | FF10 | D | CNT | 1D | | | | | | | | |
| | U | INPUT | 2D | ADSORB | D | EROSIO | 2D | COMPUT | D | FLRM | D | ATMOS | 6D | | | | | | |
| | UD | BURYIT | 4D | EXEC | 1D | UNSAT | D | | | | | | | | | | | | |
| | UC | DOSET | 2D | | | | | | | | | | | | | | | | |
| | UCRAIN | DOSET | 4CD | | | | | | | | | | | | | | | | |
| | ULCF | FERRNT | 2D | | | | | | | | | | | | | | | | |
| | ULPS | FERRNT | 1CD | | | | | | | | | | | | | | | | |
| | UMEAT | DOSET | 4CD | | | | | | | | | | | | | | | | |
| | UMILK | DOSET | 4CD | | | | | | | | | | | | | | | | |
| | UNK | DOSET | 2D | | | | | | | | | | | | | | | | |
| | UNT | DOSET | 2D | | | | | | | | | | | | | | | | |
| S | UNSAT | EXEC | 1 | UNSAT | 1 | | | | | | | | | | | | | | |
| | UV | DOSET | 2D | | | | | | | | | | | | | | | | |
| | UVEC | DOSET | 4CD | | | | | | | | | | | | | | | | |
| | V | UNSAT | 24D | FF10 | 5D | COMPUT | 6 | FIN | 10 | DINT | 12D | | | | | | | | |
| | V1 | FIN | 6D | DINT | CD | | | | | | | | | | | | | | |
| | V2 | FIN | 5D | DINT | CD | | | | | | | | | | | | | | |
| | *V3 | DINT | CD | | | | | | | | | | | | | | | | |
| L | VAR | BURYIT | 1 | EXEC | 1 | INPUT | 1 | EROSIO | 1 | COMPUT | 1 | ATMOS | 1 | | | | | | |
| L | VAR1 | BLDATA | 1 | LPRIME | 1 | IPRIME | 1 | KPRIME | 1 | FLRM | 1 | VEC | 1 | | | | | | |
| L | VAR2 | INPUT | 1 | ADSORB | 1 | EROSIO | 1 | COMPUT | 1 | FLRM | 1 | ATMOS | 1 | | | | | | |
| | VD | BURYIT | D | EXEC | D | OUTPUT | D | PREDOS | 2D | ATMOS | 4D | DOSET | D | SUMDOS | D | | | | |
| | VD1 | ATMOS | 3 | | | | | | | | | | | | | | | | |
| S | VEC | COMPUT | 4 | VEC | 1 | | | | | | | | | | | | | | |
| | VECCVR | BLDATA | CD | LPRIME | D | IPRIME | D | KPRIME | D | FLRM | D | VEC | 3D | | | | | | |
| | VH1 | FLRM | 4 | | | | | | | | | | | | | | | | |
| | VH2 | FLRM | 3 | | | | | | | | | | | | | | | | |
| | *VL | DOSET | CD | | | | | | | | | | | | | | | | |
| | VOL | BURYIT | 5D | EXEC | 1D | UNSAT | D | | | | | | | | | | | | |
| | VOLA | BURYIT | 1D | | | | | | | | | | | | | | | | |
| | VOLWAT | UNSAT | 3D | ADSORB | 13D | | | | | | | | | | | | | | |
| | VT | FF10 | 1D | FIN | 2D | | | | | | | | | | | | | | |
| | VZ | EXEC | 2D | INPUT | 1D | AQUIFR | 3D | CNT | 1D | | | | | | | | | | |
| | W | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 44D | ADSORB | 3D | FIXTIM | D | ATMOS | D |
| | | DOSET | 2C | DIRECT | D | | | | | | | | | | | | | | |
| | *WA | DOSET | D | | | | | | | | | | | | | | | | |
| | WAT | UNSAT | 2 | | | | | | | | | | | | | | | | |
| | WATB | TMLIST | 1 | | | | | | | | | | | | | | | | |
| | WATH | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 11D | ADSORB | D | FIXTIM | D | ATMOS | D |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| | WATL | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 0D | ADSORB | D | FIXTIM | D | ATMOS | D |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| | WC | BURYIT | D | EXEC | 2D | OUTPUT | D | PREDOS | D | ATMOS | D | DOSET | 2D | SUMDOS | D | | | | |
| | WDF | ATMOS | 2 | | | | | | | | | | | | | | | | |
| | WFDD | UNSAT | 6 | TMLIST | 2 | | | | | | | | | | | | | | |
| | WFUU | UNSAT | 3 | | | | | | | | | | | | | | | | |
| | WIND | BLDATA | CD | LPRIME | D | IPRIME | 1D | KPRIME | D | FLRM | D | VEC | D | | | | | | |
| | WKP | UNSAT | 2 | | | | | | | | | | | | | | | | |
| | WN | FERRNT | 5D | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WNDERN | BLDATA | CD | LPRIME | 3D | IPRIME | D | KPRIME | D | FLRM | D | VEC | D | | | | | | |
| | WNDFRC | BURYIT | D | EXEC | D | INPUT | D | EROS10 | 6D | COMPUT | 1D | LPRIME | 4 | ATMOS | D | | | | |
| F | WRITE | BURYIT | 22 | EXEC | 11 | OUTPUT | 36 | PREDOS | 1 | UNSAT | 27 | TMLIST | 8 | AQUIFR | 1 | SWD | 1 | EROS10 | 3 |
| | | SUMDOS | 1 | | | | | | | | | | | | | | | | |
| | WTSOLD | UNSAT | 3D | ADSORB | 11D | | | | | | | | | | | | | | |
| | WU | DOSET | 1CD | | | | | | | | | | | | | | | | |
| | X | INPUT | 2D | FERRNT | 4D | VEC | 2 | FIN | 2 | ATMOS | 2 | SIGMAZ | 5 | DINT | 3 | EXPF | 4 | DIRECT | 9 |
| | X1 | FIN | 2 | | | | | | | | | | | | | | | | |
| | X2 | FIN | 2 | | | | | | | | | | | | | | | | |
| | XB | DINT | 4CD | | | | | | | | | | | | | | | | |
| | XCON | INPUT | 2 | | | | | | | | | | | | | | | | |
| | XD | BURYIT | D | EXEC | D | INPUT | 1D | OUTPUT | D | PREDOS | D | UNSAT | 1D | ADSORB | 7D | FIXTIM | D | ATMOS | D |
| | | DOSET | D | DIRECT | D | | | | | | | | | | | | | | |
| L | XDATA | BURYIT | 1 | EXEC | 1 | INPUT | 1 | OUTPUT | 1 | PREDOS | 1 | UNSAT | 1 | AQUIFR | 1 | EROS10 | 1 | | |
| | XL | SUM2 | 7 | DINT | 3 | | | | | | | | | | | | | | |
| | XM | ATMOS | 3 | DIRECT | 6 | | | | | | | | | | | | | | |
| | XMEAT | DOSET | 1CD | | | | | | | | | | | | | | | | |
| | *XMILK | DOSET | CD | | | | | | | | | | | | | | | | |
| | XMU | DIRECT | 2CD | | | | | | | | | | | | | | | | |
| | XNCOUT | EXEC | 2D | EROS10 | 5D | | | | | | | | | | | | | | |
| | XNUCIN | EXEC | 2D | EROS10 | 3D | | | | | | | | | | | | | | |
| | XOQ | ATMOS | 4 | | | | | | | | | | | | | | | | |
| | XR | SUM2 | 7 | | | | | | | | | | | | | | | | |
| | XT | UNSAT | 2 | | | | | | | | | | | | | | | | |
| | XTIME | UNSAT | 5 | | | | | | | | | | | | | | | | |
| | XZ | EXEC | D | INPUT | 1D | AQUIFR | 3D | CNT | 1D | | | | | | | | | | |
| | Y | UNSAT | 15D | FERRNT | 6D | FIN | 2 | | | | | | | | | | | | |
| | Y1 | FIN | 2 | | | | | | | | | | | | | | | | |
| | Y2 | FIN | 2 | | | | | | | | | | | | | | | | |
| | YSOL | UNSAT | 2D | | | | | | | | | | | | | | | | |
| | YSQ | FERRNT | 8D | | | | | | | | | | | | | | | | |
| | Z | INTER | 0 | FIN | 9 | | | | | | | | | | | | | | |
| | Z1 | FIN | 10 | | | | | | | | | | | | | | | | |
| | Z2 | FIN | 10 | | | | | | | | | | | | | | | | |
| | ZA | SUM2 | 4 | | | | | | | | | | | | | | | | |
| | ZERO | FERRNT | 7CD | | | | | | | | | | | | | | | | |
| | Z1 | SUM2 | 6 | | | | | | | | | | | | | | | | |
| | ZL | SUM2 | 10 | | | | | | | | | | | | | | | | |

ROUTINES INDEXED


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| ATMOS | 111 | DINT | 118 | EXEC | 11 | FIN | 108 | INPUT | 19 | LPRIME | 94 | SUM2 | 78 | UNSAT | 35 | | |
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# APPENDIX E

# SENSITIVITY STUDY RESULTS

AIR PATH SENSITIVITY
STUDY RESULTS

| VARIABLE LEVELS | CUMULATIVE DOSE |
|---|---|
| 111311111311 | 1.433906E+01 |
| 111323111311 | 0.000000E+00 |
| 111332111311 | 0.000000E+00 |
| 112211111311 | 2.606521E+01 |
| 112223111311 | 0.000000E+00 |
| 112232111311 | 0.000000E+00 |
| 113111111311 | 3.367003E+01 |
| 113123111311 | 0.000000E+00 |
| 113132111311 | 0.000000E+00 |
| 121212111311 | 0.000000E+00 |
| 121221111311 | 1.995497E+03 |
| 121233111311 | 0.000000E+00 |
| 122112111311 | 0.000000E+00 |
| 122121111311 | 2.004049E+03 |
| 122133111311 | 0.000000E+00 |
| 123312111311 | 0.000000E+00 |
| 123321111311 | 1.859702E+03 |
| 123333111311 | 0.000000E+00 |
| 131113111311 | 0.000000E+00 |
| 131122111311 | 0.000000E+00 |
| 131131111311 | 0.000000E+00 |
| 132313111311 | 0.000000E+00 |
| 132322111311 | 0.000000E+00 |
| 132331111311 | 0.000000E+00 |
| 133213111311 | 0.000000E+00 |
| 133222111311 | 0.000000E+00 |
| 133231111311 | 0.000000E+00 |
| 211212111311 | 0.000000E+00 |
| 211221111311 | 1.791864E+01 |
| 211233111311 | 0.000000E+00 |
| 212112111311 | 0.000000E+00 |
| 212121111311 | 1.968141E+01 |
| 212133111311 | 0.000000E+00 |
| 213312111311 | 0.000000E+00 |
| 213321111311 | 1.534214E+01 |
| 213333111311 | 0.000000E+00 |
| 221113111311 | 0.000000E+00 |
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| 132331331311 | 0.000000E+00 |
| 133213331311 | 0.000000E+00 |
| 133222331311 | 0.000000E+00 |
| 133231331311 | 0.000000E+00 |
| 211212331311 | 0.000000E+00 |
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| 211233331311 | 0.000000E+00 |
| 212112331311 | 0.000000E+00 |
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| 212133331311 | 0.000000E+00 |
| 213312331311 | 0.000000E+00 |
| 213321331311 | 5.374263E-02 |
| 213333331311 | 0.000000E+00 |

| | |
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| 221113331311 | 0.000000E+00 |
| 221122331311 | 0.000000E+00 |
| 221131331311 | 0.000000E+00 |
| 222313331311 | 0.000000E+00 |
| 222322331311 | 0.000000E+00 |
| 222331331311 | 0.000000E+00 |
| 223213331311 | 0.000000E+00 |
| 223222331311 | 0.000000E+00 |
| 223231331311 | 0.000000E+00 |
| 231311331311 | 9.261805E+01 |
| 231322331311 | 0.000000E+00 |
| 231332331311 | 0.000000E+00 |
| 232211331311 | 9.098457E+01 |
| 232223331311 | 0.000000E+00 |
| 232232331311 | 0.000000E+00 |
| 233111331311 | 8.862335E+01 |
| 233123331311 | 0.000000E+00 |
| 233132331311 | 0.000000E+00 |
| 311113331311 | 7.646155E+00 |
| 311122331311 | 0.000000E+00 |
| 311131331311 | 0.000000E+00 |
| 312313331311 | 2.145139E+00 |
| 312322331311 | 0.000000E+00 |
| 312331331311 | 0.000000E+00 |
| 313213331311 | 3.267649E+00 |
| 313222331311 | 0.000000E+00 |
| 313231331311 | 0.000000E+00 |
| 321311331311 | 1.979028E+01 |
| 321323331311 | 4.180336E+02 |
| 321332331311 | 1.873784E+02 |
| 322211331311 | 1.673484E+01 |
| 322223331311 | 3.523282E+02 |
| 322232331311 | 1.584854E+02 |
| 323111331311 | 1.489473E+01 |
| 323123331311 | 3.122247E+02 |
| 323132331311 | 1.410734E+02 |
| 331212331311 | 0.000000E+00 |
| 331221331311 | 2.295005E+02 |
| 331233331311 | 7.113770E+03 |
| 332112331311 | 0.000000E+00 |
| 332121331311 | 1.932692E+02 |
| 332133331311 | 5.992484E+03 |
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| 333321331311 | 1.703686E+02 |
| 333333331311 | 5.283593E+03 |
| 111311331333 | 5.146237E-06 |
| 111323331333 | 1.216420E-04 |
| 111332331333 | 4.726017E-05 |
| 112211331333 | 9.178380E-06 |
| 112223331333 | 2.169432E-04 |
| 112232331333 | 8.428914E-05 |
| 113111331333 | 1.146923E-05 |
| 113123331333 | 2.766454E-04 |
| 113132331333 | 1.053123E-04 |
| 121212331333 | 5.473397E-03 |
| 121221331333 | 7.161767E-04 |
| 121233331333 | 5.891601E-02 |
| 122112331333 | 5.393113E-03 |
| 122121331333 | 7.056887E-04 |
| 122133331333 | 5.805926E-02 |
| 123312331333 | 4.914778E-03 |
| 123321331333 | 6.334814E-04 |
| 123333331333 | 5.112925E-02 |
| 131113331333 | 1.828303E-01 |
| 131122331333 | 6.159751E-02 |
| 131131331333 | 8.059839E-03 |

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| 132313331333 | 1.790902E-01 |
| 132322331333 | 6.033834E-02 |
| 132331331333 | 7.895267E-03 |
| 133213331333 | 1.665910E-01 |
| 133222331333 | 5.561387E-02 |
| 133231331333 | 7.168252E-03 |
| 211212331333 | 3.313105E-05 |
| 211221331333 | 4.562919E-06 |
| 211233331333 | 4.668890E-04 |
| 212112331333 | 3.511406E-05 |
| 212121331333 | 4.836528E-06 |
| 212133331333 | 4.950994E-04 |
| 213312331333 | 2.649954E-05 |
| 213321331333 | 3.650131E-06 |
| 213333331333 | 3.737169E-04 |
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| 221122331333 | 4.149085E-03 |
| 221131331333 | 5.714257E-04 |
| 222313331333 | 1.146854E-02 |
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| 222331331333 | 5.500803E-04 |
| 223213331333 | 1.110230E-02 |
| 223222331333 | 3.866249E-03 |
| 223231331333 | 5.325494E-04 |
| 231311331333 | 6.452385E-03 |
| 231322331333 | 1.345482E-01 |
| 231332331333 | 4.685032E-02 |
| 232211331333 | 6.223978E-03 |
| 232223331333 | 1.297627E-01 |
| 232232331333 | 4.518718E-02 |
| 233111331333 | 6.019188E-03 |
| 233123331333 | 1.254847E-01 |
| 233132331333 | 4.369862E-02 |
| 311113331333 | 2.742090E-03 |
| 311122331333 | 8.297196E-04 |
| 311131331333 | 9.153873E-05 |
| 312313331333 | 7.369251E-04 |
| 312322331333 | 2.229866E-04 |
| 312331331333 | 2.460060E-05 |
| 313213331333 | 1.038530E-03 |
| 313222331333 | 3.142736E-04 |
| 313231331333 | 3.466862E-05 |
| 321311331333 | 2.652997E-03 |
| 321323331333 | 1.353027E-01 |
| 321332331333 | 4.337703E-02 |
| 322211331333 | 2.138728E-03 |
| 322223331333 | 1.090871E-01 |
| 322232331333 | 3.497034E-02 |
| 323111331333 | 1.749709E-03 |
| 323123331333 | 8.926439E-02 |
| 323132331333 | 2.860549E-02 |
| 331212331333 | 4.436266E-01 |
| 331221331333 | 3.399684E-02 |
| 331233331333 | 1.639437E+00 |
| 332112331333 | 3.561521E-01 |
| 332121331333 | 2.729047E-02 |
| 332133331333 | 1.316005E+00 |
| 333312331333 | 2.887582E-01 |
| 333321331333 | 2.211399E-02 |
| 333333331333 | 1.065910E+00 |

WATER PATH SENSITIVITY
STUDY RESULTS

| VARIABLE LEVELS | CUMULATIVE DOSE |
|---|---|
| 113111113 | 0.366887E+00 |
| 131111113 | 0.790207E+00 |
| 311111113 | 0.801555E+00 |
| 233111113 | 0.731773E-01 |
| 323111113 | 0.305755E+00 |
| 332111113 | 0.170416E+00 |
| 122111113 | 0.817210E+00 |
| 212111113 | 0.855291E+00 |
| 221111113 | 0.746423E+00 |
| 113111131 | 0.366887E+02 |
| 131111131 | 0.790207E+02 |
| 311111131 | 0.801555E+02 |
| 233111131 | 0.731774E+01 |
| 323111131 | 0.305755E+02 |
| 332111131 | 0.170416E+02 |
| 122111131 | 0.817210E+02 |
| 212111131 | 0.855291E+02 |
| 221111131 | 0.746424E+02 |
| 113113313 | 0.441430E+00 |
| 131113313 | 0.188487E+00 |
| 311113313 | 0.287139E+00 |
| 233113313 | 0.396551E-02 |
| 323113313 | 0.463519E-01 |
| 332113313 | 0.976158E-02 |
| 122113313 | 0.684120E+00 |
| 212113313 | 0.102787E+01 |
| 221113313 | 0.134761E+00 |
| 113113331 | 0.441430E+02 |
| 131113331 | 0.188487E+02 |
| 311113331 | 0.287139E+02 |
| 233113331 | 0.396551E+00 |
| 323113331 | 0.463519E+01 |
| 332113331 | 0.976158E+00 |
| 122113331 | 0.684120E+02 |
| 212113331 | 0.102787E+03 |
| 221113331 | 0.134761E+02 |
| 113131311 | 0.315060E-15 |
| 131131311 | 0.566724E+02 |
| 311131311 | 0.571639E+02 |
| 233131311 | 0.628372E-16 |
| 323131311 | 0.262557E-15 |
| 332131311 | 0.337048E+00 |
| 122131311 | 0.161715E+01 |
| 212131311 | 0.169113E+01 |
| 221131311 | 0.531581E+02 |
| 113131333 | 0.315060E-17 |
| 131131333 | 0.566724E+00 |
| 311131333 | 0.571658E+00 |
| 233131333 | 0.628372E-18 |
| 323131333 | 0.262557E-17 |
| 332131333 | 0.337048E-02 |
| 122131333 | 0.161715E-01 |
| 212131333 | 0.169113E-01 |
| 221131333 | 0.531581E+00 |
| 113133111 | 0.226537E-15 |
| 131133111 | 0.593071E+02 |
| 311133111 | 0.229618E+02 |
| 233133111 | 0.203353E-17 |
| 323133111 | 0.236710E-16 |
| 332133111 | 0.204936E-01 |

| | |
|---|---|
| 122133111 | 0.149796E+01 |
| 212133111 | 0.222202E+01 |
| 221133111 | 0.287657E+02 |
| 113133133 | 0.226537E-17 |
| 131133133 | 0.593071E+00 |
| 311133133 | 0.229618E+00 |
| 233133133 | 0.203353E-19 |
| 323133133 | 0.236710E-18 |
| 332133133 | 0.204936E-03 |
| 122133133 | 0.149796E-01 |
| 212133133 | 0.222202E-01 |
| 221133133 | 0.287657E+00 |
| 113311311 | 0.728610E+04 |
| 131311311 | 0.130146E+05 |
| 311311311 | 0.149912E+05 |
| 233311311 | 0.145397E+04 |
| 323311311 | 0.607339E+04 |
| 332311311 | 0.321484E+04 |
| 122311311 | 0.153630E+05 |
| 212311311 | 0.161634E+05 |
| 221311311 | 0.143615E+05 |
| 113311333 | 0.728610E+02 |
| 131311333 | 0.130146E+03 |
| 311311333 | 0.149912E+03 |
| 233311333 | 0.145397E+02 |
| 323311333 | 0.607339E+02 |
| 332311333 | 0.321484E+02 |
| 122311333 | 0.153630E+03 |
| 212311333 | 0.161634E+03 |
| 221311333 | 0.143615E+03 |
| 113313111 | 0.893013E+04 |
| 131313111 | 0.157815E+05 |
| 311313111 | 0.636436E+04 |
| 233313111 | 0.801687E+02 |
| 323313111 | 0.933600E+03 |
| 332313111 | 0.206982E+03 |
| 122313111 | 0.150340E+05 |
| 212313111 | 0.223464E+05 |
| 221313111 | 0.769496E+04 |
| 113313133 | 0.893013E+02 |
| 131313133 | 0.157815E+03 |
| 311313133 | 0.636436E+02 |
| 233313133 | 0.801688E+00 |
| 323313133 | 0.933600E+01 |
| 332313133 | 0.206982E+01 |
| 122313133 | 0.150340E+03 |
| 212313133 | 0.223464E+03 |
| 221313133 | 0.769496E+02 |
| 113331113 | 0.372092E-15 |
| 131331113 | 0.114604E+03 |
| 311331113 | 0.115440E+03 |
| 233331113 | 0.742109E-16 |
| 323331113 | 0.310084E-15 |
| 332331113 | 0.674927E+00 |
| 122331113 | 0.323855E+01 |
| 212331113 | 0.338629E+01 |
| 221331113 | 0.107309E+03 |
| 113331131 | 0.372092E-13 |
| 131331131 | 0.114604E+05 |
| 311331131 | 0.115440E+05 |
| 233331131 | 0.742110E-14 |
| 323331131 | 0.310084E-13 |
| 332331131 | 0.674927E+02 |
| 122331131 | 0.323855E+03 |
| 212331131 | 0.338629E+03 |
| 221331131 | 0.107309E+05 |

| | |
|---|---|
| 113333313 | 0.767188E-15 |
| 131333313 | 0.116486E+03 |
| 311333313 | 0.454642E+02 |
| 233333313 | 0.688699E-17 |
| 323333313 | 0.801716E-16 |
| 332333313 | 0.409367E-01 |
| 122333313 | 0.298980E+01 |
| 212333313 | 0.443608E+01 |
| 221333313 | 0.565693E+02 |
| 113333331 | 0.767187E-13 |
| 131333331 | 0.116486E+05 |
| 311333331 | 0.454642E+04 |
| 233333331 | 0.688699E-15 |
| 323333331 | 0.801715E-14 |
| 332333331 | 0.409367E+01 |
| 122333331 | 0.298980E+03 |
| 212333331 | 0.443608E+03 |
| 221333331 | 0.565693E+04 |

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16. ABSTRACT (200 words or less)

A systems model for shallow land burial of low-level waste was assembled from existing models available in the nuclear industry. The model covers waste packaging, transportation, burial, and post burial activities. Subprograms were developed for unsaturated zone seepage, aquifer transport, wind erosion, and atmospheric transport. Release via available pathways are converted to population dose commitments using standard regulatory guide and ICRP Techniques. The system model starts with an initiating event selected from a list of scenarios from an event Tree Analysis Pathway Sequence, inventory, and release fraction for each scenario are available within a standard data base. The executive program which executes the system model calls subroutine in proper sequence and provides for the analysis of several hundred accident and scenario possiblilites.

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